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**ECONOMIC IMPACT OF ANTICIPATED
PAPER INDUSTRY POLLUTION –
ABATEMENT COSTS**

PART II: INDUSTRY STRUCTURE AND BUSINESS OUTLOOK

report to

**THE COUNCIL ON
ENVIRONMENTAL QUALITY**

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December 1971

C-73977

Arthur D Little Inc.

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I. SUMMARY

A. PURPOSE AND SCOPE

Presented is
This is the first of two reports developed under contract with the Council on Environmental Quality to assess how costs associated with new environmental protection standards will affect the pulp and paper industry. The purpose of this report is to describe industry characteristics and trends that are relevant to this economic analysis. Thus this report serves to focus the analysis on those sectors of the industry that will be most adversely affected. A more detailed analysis of specific economic adjustment problems is given in Part III. (Part I summarizes both reports.)

B. APPROACH

The information contained in this report is based primarily upon our background knowledge developed through our consulting experience in the paper industry plus reference to numerous sources of current statistical information. Of substantial assistance were the supply/demand data and analyses of industry profitability trends compiled by the American Paper Institute.

The basic approach used in our analysis was to subdivide the industry into its major product sectors. We then made an assessment of which mills in each sector are marginally profitable in today's market; our assessment was based mainly on paper machine- and mill-size criteria, but also took into account the relative severity of pollution control problems for each sector, current overcapacity and price weakness, the degree of vertical integration of the facility, and current industry profit levels. Finally, we evaluated future supply/demand trends in each sector to determine the likelihood that future price increases can be obtained to restore profitability to an adequate level and to absorb additional pollution abatement costs. The basic assumptions made in the latter analysis were: (1) real growth in gross national product will average 4%/year between 1971 and 1976 with somewhat higher growth (5%/year) in 1972 and 1973; and (2) the industry will be able to operate without price controls.

C. CONCLUSIONS

Paper industry profitability is at its lowest point since World War II with after-tax return on total assets averaging about 3% in the first 9 months of 1971. Thus this industry's ability to finance the capital costs and absorb the additional operating costs necessary for pollution abatement will depend on its ability to improve profits through price and productivity improvements.

We anticipate improved operating rates in most sectors of the industry by 1973 assuming real GNP growth of 5% in 1972 and 1973. Therefore, the market environment should generally provide increased mill utilization and be conducive to price increases, if it is allowed to operate freely. Between 1974 and 1976 we expect that operating rates will probably decline again, judging from previous cycles in this industry.

Significant overcapacity is expected to continue through 1973 in three product sectors: insulation board, semi-chemical corrugating medium and special industrial paper. Thus mills in these sectors will have great difficulty in coping with additional pollution abatement costs.

Small producers who are not integrated to pulp or who have sulfite pulp mills which must be closed because it is not feasible to equip them for chemical recovery also are expected to have particular difficulty in coping with increased pollution costs. Despite improvements in operating rate and price these producers will be caught in a cost/price squeeze because of the rapid increase in market pulp and waste paper prices foreseen for the next several years. Moreover, many of these mills are obsolete by today's standards. Particularly affected will be the smaller producers of tissue, printing and writing papers.

Finally, we expect to see continued dislocations, caused in part by increased pollution abatement requirements, among the combination paperboard producers. Although many of these mills have closed over the past 18 months, many similarly marginal mills continue to operate. A number of these can be expected to close despite the modest improvement in operating rates foreseen in this product sector through 1973. Many certainly will not survive another economic recession beyond 1973.

We expect the greatest regional dislocations to occur in the New England, Mid-Atlantic and North Central areas — where most of the marginal producers of the above products are found. Moreover, the mills in these regions are more apt to experience site constraints in dealing with their pollution abatement problems or be under increased clean-up pressures because of their proximity to urban areas.

II. INDUSTRY CHARACTERISTICS AND TRENDS

A. COMPANY CHARACTERISTICS

The U.S. Pulp and Paper Industry (excluding independent converting operations) consists of approximately 450 companies operating about 673 manufacturing establishments. Of these 673 about 120 are in New England, 133 in the Middle Atlantic region, 156 in the East North Central region, 21 in the West North Central section, 69 in the South Atlantic area, 46 in the East South Central region, 44 in the West South Central region, and 84 in the West (Figure 1).

Of the 450 companies in the industry, the top 20 account for 65-70% of pulp paper and paperboard value of shipments, while the top 50 firms account for about 90% of the output. These are typically companies integrated to pulp manufacture and having sales greater than \$40 million per year.

The top 20 companies generally produce papermaking pulps in tonnages equivalent to their captive needs. Usually, they manufacture commodity paper and board products, being the major producers of such items as linerboard, corrugated medium, solid bleached board and sack kraft paper. The major operations of these companies characteristically are located in the deep South and in the Pacific Northwest. In addition, as a result of properties owned for many years in the Northeast many of these companies manufacture specialty paper goods as well as the commodity items discussed above. Thus, for example, International Paper Company and St. Regis Paper Company have major operations located in the North in addition to major mill complexes in the South.

At the other end of the spectrum are the family-owned single-mill concerns, characteristically located in the New England, Mid-Atlantic and North Central regions, which produce specialty paper materials in tonnage ranges from less than 10 tons per day to several hundred tons per day. These manufacturers usually rely on purchased pulp, although in certain instances they operate small pulp mills.

Between these two opposites resides the medium-size company of the industry, usually a pulp producer, and often a net buyer of pulp as well. These companies tend to concentrate on a rather narrow product range and are not as diversified in terms of the kinds of paper and board products they can supply as are the major companies in the industry.

B. PHYSICAL STRUCTURE OF THE INDUSTRY

1. Regionality Factors

a. Historical

The U.S. Pulp and Paper Industry had its principal beginnings in New England in the 1800's with the development of papermaking, groundwood pulping and sulfite pulping to supply the growing paper needs of the Northeast section of the country. The relative proximity of the growing population centers to the large resources of high-quality softwood pulpwood in northern New England and New York State was a substantial factor in the development of the infrastructure of the area as the Northeast continued to grow and develop. As a result, even today there is a substantial amount of papermaking in the area bounded on the west by the Ohio border and on the south by Virginia.

As the country grew and spread westward and to the south, the need for substantial wood supplies for pulping (and for lumber and plywood as well) outstripped the capabilities of the northeastern area to meet the burgeoning market demands and in particular the demands of regions far removed from New England.

b. Wood Supplies

Several sectors of the country have commercial forest resources:

- (1) The northeastern region is a mixture of northern softwood species ranging from pine to spruce, hemlock and fir; concentrations of softwood species generally increase in the more northerly regions and those of higher elevations. In addition, the area has substantial volumes of mixed hardwood species (which also may be used for paper with today's technology) ranging from the desirable maple, beech and birch groups to the less valuable (and sometimes useless) oaks, elm and other mixed hardwoods. With the exception of northwestern Maine, the Northeast no longer possesses substantial untapped tracts of softwood species. The area also has some untapped hardwood reserves throughout northern and central Maine and in the area bounded by the Connecticut River and Lake Ontario, north of Albany.

However, the major growth in the pulp and paper industry of the future will not involve the Northeastern sector of the country, and increases in capacity in this region will be limited for the most part to incremental additions to the manufacturing capabilities of existing facilities in order to optimize the utilization of local resources and to raise manufacturing efficiencies.



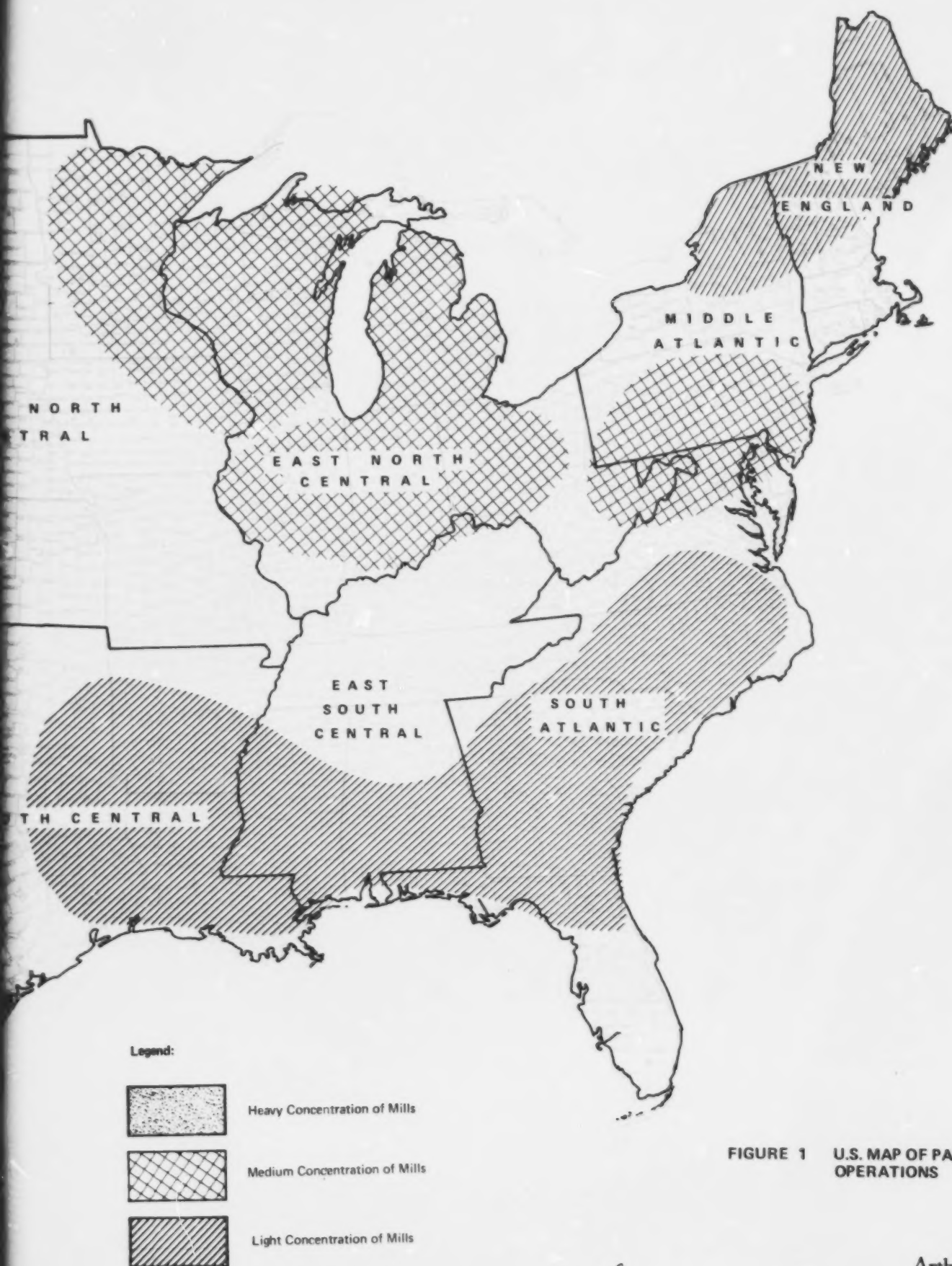


FIGURE 1 U.S. MAP OF PAPERMAKING OPERATIONS

- (2) The major forest reserves in the United States are in the *deep south* (with the exception of southern Florida), bounded by North Carolina on the north and eastern Texas on the west. This area is the country's major source of pulp and paper products.

The southern industry had its beginnings with the development of the kraft pulping process which evolved in the 1930's and provided a method of producing high-strength unbleached packaging materials from southern pinewood to meet the packaging demands as industrial America grew. Today approximately 75% of the paper and board products used in the United States originate with southern kraft pulping. Furthermore, kraft pulping throughout the country accounts for approximately 90% of the total chemical pulp produced.

- (3) Michigan, Wisconsin, and parts of Minnesota also are substantial producers of pulp and paper products. The wood species and availability of this region are not substantially different from New England's and the only major difference between the two areas is that the midwestern area was developed somewhat later than New England and New York.

Nevertheless, the softwood reserves in the Midwest are essentially exhausted. Although some supply of hardwood pulpwood could be developed, the Midwest (like New England) will not contribute substantially to the growth of the industry in the years ahead.

- (4) The fourth major sector of the U.S. pulp and paper industry is in Washington, Oregon and northern California and comprises about 15% of the total industry. Wood resources in the Northwest are essentially softwood resources, and substantial quantities of timber are as yet untapped for the production of pulp as well as for lumber and plywood.

However, the mountainous terrain and relatively remote location from major markets have somewhat restricted the growth of the industry in this locale. Most of the products made here are utilized in the western markets or are exported (but some western pulps are seen in Chicago and even on the east coast).

- (5) Finally, there are substantial reserves of untapped timber throughout the *Rocky Mountain region* extending from a line drawn between Denver, Colorado, and Helena, Montana, to California, excluding the plateau prairie lands in Utah and Nevada. As the

country's needs for wood raw materials continue to grow, a substantial portion of this need will be filled by these resources, resulting in substantial new increments of manufacturing capacity for pulp, paper, lumber and plywood in the Northwest and in the Rocky Mountain area. This will supplement future growth in the deep South.

2. Production Processes

The pulp and paper industry has many of the characteristics of the chemical process industries, since it embodies many of the technical functions and design methods employed in the manufacture of such products as inorganics and petrochemicals as well as in the refining of oil. The major process steps are pulping (the digestion or separation of whole wood into a fibrous mass) and papermaking (the formation of the discrete fibers into a web or sheet of paper or board). In addition, particularly in the papermaking part of the process, special highly specific manufacturing techniques have been developed and are standardized throughout the industry.

Manufacturing plants vary widely in complexity – from small plants that produce low-tonnage products from purchased pulps to large integrated facilities that receive harvested timber, convert it to pulp, and then convert the pulp to paper and board. For the most part, pulp manufacturing operations are coupled to chemical recovery processes, which provide for waste disposal by incineration together with recovery of the inorganic chemicals employed in the pulping process.

In addition a substantial converting sector of the industry is sometimes physically integrated into the papermaking process. Alternatively, it may be physically removed from paper manufacture and independently organized in a corporate sense.

The major process steps in the industry are described below.

a. Pulping

There are two major methods for converting wood to papermaking pulps: Mechanical Pulping and Chemical Pulping. In addition, each of these pulping procedures is broken down into two or more sub-methods:

(1) *Mechanical Pulping.* Mechanical pulping is either of two physical methods employed to produce groundwood pulps. In the older technology of the two, stonegrinding, pulpwood logs are ground on large grindstones. The newer technology, chip refining, converts pulpwood chips to groundwood pulp using

attrition mills called refiners. Chip refining finds most of its application with raw material derived from the waste produced in sawmills and other wood products operations. Essentially all groundwood pulp, whether of the stone or refiner type, is produced from softwood raw materials – spruce in the Northeast, pine in the South, and Douglas fir and hemlock on the West Coast. Aspen, a low-density hardwood, is used for some groundwood production in the North Central region.

(2) *Chemical Pulps.* A high percentage of the chemical pulp produced today is manufactured by the kraft process, which finds substantial utility in the manufacture of softwood as well as of hardwood pulps. The process is also commonly termed the sulfate process, because sodium sulfate is used as make-up chemical. The kraft process employs a water solution of sodium sulfide and sodium hydroxide to dissolve the lignin and pentosan fractions of wood while leaving the cellulose portion untouched. This cooking process is achieved in high-temperature batch or continuous reactor vessels after which the pulp is separated from the cooking liquor, usually with countercurrent rotary vacuum filters. The pulp enters into a number of process operations before its ultimate conversion to paper, and the waste liquor from the pulping step is fed to a kraft recovery system which provides for incineration of the dissolved organic chemicals and the recovery and reconstitution of the sodium sulfide and sodium hydroxide values for recycle to the pulping step. Incineration, recovery of chemicals, and recycle are an economic necessity in kraft pulping because of high chemical loading in the digesters. The incineration process, however, creates the significant air pollution problems associated with the kraft process.

The other major chemical pulping process is the sulfite process, wherein the chemicals employed in dissolving the undesirable constituents of wood comprise a water solution of a cationic material, typically sodium, magnesium, or ammonia (sometimes calcium) as the sulfite salt mixed with excess amounts of SO_2 or alkali (depending upon pH). Again lignin and other undesirable chemicals are dissolved from the wood, producing a waste liquor which is separated from the pulp. The chemical requirements and costs are far lower than for the kraft process; hence these liquors historically have been discarded without treatment.

With the ammonium and magnesium sulfite processes, recovery technology is available for treatment of pulp mill waste liquors and recovery of chemicals. Adaptation of these techniques in the industry has been slow because of the added cost burden, but is now under way. In the sodium sulfite process, no economically attractive chemical recovery method is available and current practice involves liquor disposal into rivers and streams. In addition, straight incineration is employed, in certain cases, to produce an inert ash for disposal.

A special sector of the sulfite industry is known as the neutral sulfite semi-chemical (NSSC) process. By this method, hardwood pulpwood is converted into a special high-yield pulp used almost exclusively for the manufacture of corrugating medium, the fluting material found in corrugated containers. NSSC pulp is usually manufactured by the sodium neutral sulfite process (although ammonia is sometimes used). Like other sectors of the sulfite industry, the sodium neutral sulfite pulping process has no economic recovery system which may be applied to the waste stream from the pulping process. In certain instances specially designed incineration systems are employed, producing an inert ash material, a mixture of sodium sulfate and sodium carbonate. This ash is often produced in substantial quantities and must therefore be either sold or discarded.

In ammonium base semi-chemical pulping the same recovery procedures as are employed for full ammonium sulfite pulping may be applied. These generally involve concentration and incineration of waste material, producing a tail gas containing SO_2 which may then be recovered. The ammonia is oxidized to nitrogen and discharged to the atmosphere.

As in the kraft industry, the sulfite pulp is usually recovered by filtration and subjected to further processing before finally being manufactured into paper.

b. Pulp Bleaching

Unbleached pulps are typically dark brown and many of these pulps (typically southern pine) are employed in the unbleached state. For example, corrugated containers and grocery bags are manufactured from unbleached southern kraft pulp. On the other hand, many pulps and recycled papers are bleached before being converted to paper, and the bleaching technology is highly variable depending upon the pulp produced and the paper products desired.

Almost invariably, however, the major portion of the bleaching step involves the use of chlorine as a bleaching agent followed by extraction of the solubilized materials in sodium hydroxide solutions. The chlorination and extraction steps are followed by a series of steps, involving treatment of the partially bleached pulp with chlorine dioxide or sodium hypochlorite together with additional extraction steps as required. A minimum bleaching sequence for sulfite pulps might involve a three-step process; fully bleached kraft pulps typically involve six steps; some dissolving pulps involve as many as eight or nine bleaching steps.

The bleaching steps are generally conducted near atmospheric pressure in large stirred vessels, with filtration operations between adjacent bleaching steps to separate the pulp from the aqueous-phase spent bleaching chemicals. In all cases, pulp bleaching results in the development of substantial quantities of aqueous effluent for which no inexpensive disposal or recovery system is available. Bleach

plant effluents contain, in addition to spent and unreacted chlorine, quantities of sodium hydroxide, sodium chlorate, sodium hypochlorite, sodium chlorides, cellulose degradation products and lignin chemicals which impose a substantial biological oxygen demand (BOD) and color load on effluent receiving waters. Biological treatment of these aqueous effluents is necessary for BOD control and partial color reduction. The required secondary biological treatment to achieve these objectives is not generally practiced today.

c. Papermaking

The papermaking process is the most standardized of the manufacturing processes employed in the pulp and paper industry; it universally consists of dewatering a dilute aqueous slurry of pulp fiber through a continuous screen moving at relatively high speeds.

Most paper and board is made on Fourdrinier paper machines. The dilute aqueous slurry of pulp (called the stock) is poured onto the top of a continuous filtering screen (called the wire) which may be more than 100 feet long and up to 30 feet wide and travel over driving and support rolls at speeds ranging from several hundred to several thousand feet per minute. Water drains through the screen, leaving the paper sheet on the top; the sheet is then removed from the screen and passed through wet presses and a series of drum dryers to evaporate the water which did not drain through the screen in the formation process or which was not removed mechanically in the presses. Fourdrinier machines produce an extremely wide range of products from very lightweight materials to relatively heavy boards.

An alternative to the Fourdrinier paper machine is the so-called cylinder machine, where paper is formed on a rigid cylindrical screen immersed in the stock bath instead of a continuously travelling flexible screen with stock pumped onto the top. For the most part, cylinder machines are employed to make high-caliper board products that involve multi-ply lamination from a number of cylinders. The detailed design of a paper machine is specific for the product and caliper of materials to be manufactured; one machine design does not produce the entire spectrum of the industry's products.

After the paper is dried, it is removed from the machine and formed into large rolls, sometimes six or eight feet in diameter and ten feet wide. In certain instances (such as newsprint) these rolls are rewound and slit into smaller rolls which are sold directly to the consumer (the publisher). In other cases, rolls are converted to end products, either in operations physically adjacent to the paper-making enterprise, in separate locations within the same company, or at independent converting organizations.

3. Products

Substantial statistical information has been developed by the U.S. Department of Commerce in accordance with a product breakdown that is fairly well standardized throughout the industry. The breakdown divides the industry into two major classifications: paper products and board products, and these major classifications are broken down again into subcategories, the major sectors of which include: newsprint and other groundwood papers; coated printing, writing and fine papers; unbleached industrial and converting papers; bleached industrial and converting papers; tissue paper; containerboard (kraft liner and corrugating medium); bleached board; bogus board (including jute and chip); and a special category of building paper and boards including construction paper, insulating board and hardboard.

There are some regional characteristics to the categories. For example, essentially all the kraft linerboard (and a large percentage of the entire containerboard category) is produced in the South and Pacific Northwest. This is also true of unbleached paper and bag. Most sack kraft paper is produced from southern pine pulp. On the other hand, a large percentage of the coated and fine paper categories for business papers and printing and writing papers is produced in the older paper mills of the Northeast and the Midwest, many of which rely on purchased pulp and de-inked waste to supply raw materials. Much of the tissue paper is also manufactured in the Northeast and Midwest, principally because of the proximity to market. For the most part, the bogus and building paper and board products are produced in or near urban centers where waste fiber, the principal raw material, is more readily available.

In a gross sense, the non-integrated and older mills in the Northeast and Midwest (with their relative inefficiencies) have tended to become producers of low-volume specialty products that command higher prices and require higher levels of customer service. On the other hand, the large integrated southern mills (and some of those in the Northwest) focus on low-price commodity products because of their need to limit the number of products they produce and thereby achieve optimum manufacturing efficiencies.

The large commodity producers such as the southern sack kraft and linerboard manufacturers are the most capital intensive sector of the industry; the small bogus boxboard, tissue and fine paper mills in the Northeast and Midwest are more often the independent companies, with relatively low net worth and restricted capabilities with respect to the infusion of new capital.

4. Proximity to Markets

The tonnage producers of linerboard, kraft pulp, bag paper and other commodity items find it economically necessary to be close to forest resources. In this instance, integration is the rule. The specialty paper makers such as small tissue manufacturers and the producers of communication and fine writing papers find it necessary to be close to their markets so they can provide adequate customer service and overnight shipments and respond quickly to orders.

The specialty producers usually sell their paper in either roll form or as packaged sheets; the commodity producers of bag paper, linerboard and corrugated medium are usually integrated within their own corporations to converting operations such as the manufacture of multi-wall and grocery sacks and corrugated containers.

5. Generations of Waste

a. Airborne

By far the major air pollution problem of the pulp and paper industry is associated with the emission of particulate matter and gaseous chemicals from the kraft furnace, which is the heart of the kraft pulp mill recovery system. The kraft furnace is designed to incinerate pre-concentrated waste materials (wood-derived lignin and carbohydrate chemicals) from the kraft pulping process to carbon dioxide and water vapor and to use the generated heat to maintain the sodium and sulfur chemical values in the reduced state (as sodium sulfide) for recovery from the furnace as a smelt. Accordingly, the furnace is designed for oxidizing conditions in its upper section and reducing conditions in its lower section, and these design requirements impose certain limitations on its effectiveness. In addition, the boiler complexity and high cost are such that it is designed for operation at high thru-puts and gas velocities, resulting in high entrainment losses of particulate matter into the overhead boiler banks which are specially designed to accommodate the contaminated gas.

The results of these design and operating characteristics are: (1) the carry-out of substantial amounts of fly ash (approximately 90% sodium sulfate and 10% sodium carbonate) and (2) the evolution of varying amounts of reduced and oxidized sulfur gases - SO_2 , H_2S , various mercaptans, and higher sulfides of carbon. The use of add-on devices to reduce these emissions has not, to date, been particularly successful, and the normal kraft mill today produces high volumes of white smoke which settles to the ground surrounding the mill area and substantial quantities of gaseous effluents which creates the characteristic kraft mill odor, typically that of rotten eggs.

The industry is moving toward the application of abatement equipment to reduce these emissions, but the industry is reluctant to invest the needed capital without a foreseeable return. However, the technology is available to reduce particulate emissions extremely efficiently; the technology of gaseous emission reduction remains somewhat obscure in terms of the ultimate efficiencies of the alternative techniques being considered.

In addition, other process unit operations of the kraft recovery system involve emissions of gaseous and particulate materials. These emission points are as follows: evaporator non-condensibles, digester relief gases, smelt dissolving tank gases, causticizer tank gases, and lime kiln tail gases.

For the most part these gaseous emissions are minor compared to that of the kraft furnace itself, and their solution is relatively easy. Particulate emissions from lime kilns, and dissolving and slaking tanks can be effectively reduced by scrubbing systems. The minor gaseous emissions can be recycled normally to the kraft boiler or other incinerator for ultimate disposal.

In addition, the sulfite pulping industry is incinerating waste liquors. In some cases an inert chemical ash is produced; in others acid and/or base is recovered and recycled to the pulping system. These incineration processes produce particulate and (in certain cases) gaseous emissions of varying magnitudes, depending on the system employed. However, these emission levels are not expected to lead to the difficulties currently experienced in the kraft sector of the industry, because simple incineration procedures are employed in sulfite liquor processing.

In addition, of course, the entire pulp and paper industry employs power boilers to generate steam and electric energy by burning fossil fuels. The air pollution problems which commonly reside with the steam generating industry are typical of these operations within the pulp and paper industry. The industry is moving in the direction of purification systems for particulate removal from stack gases and anticipates the substitution of low-sulfur fuels for the standard Bunker C material which has been most often employed in the past.

b. Waterborne

All sectors of the pulp and paper industry pollute water, with most of the problems resulting from sulfite and NSSC pulp mills without recovery, from pulp bleaching plants, and from papermaking operations.

The manufacture of pulp and paper products results in an aqueous waste that poses problems because of suspended solids, BOD, color, pH, dissolved solids, and temperature. In addition, specific toxic materials may appear in some aqueous effluents.

The industry is an inherent producer of water-conveyed suspended solids and biologically active dissolved chemicals, principally cellulose derivatives. These contaminants are derived for the most part from the wood raw material employed in the pulping process or from the pulp raw material employed in non-integrated papermaking. In addition to these contaminants, pulp mills produce effluents that contain inorganic chemicals and have high and low pH's; bleach plants produce effluents that contain excess chlorine, sodium hydroxide, and spent bleaching chemicals such as chlorides, hypochlorites and chlorine dioxide. Waste sulfuric acid is generated in certain sectors of the industry (although it is usually used internally) and miscellaneous inorganic sludges – such as calcium sulfate – are produced in the recycling recovery processes employed in many pulp mills.

Paper machines produce substantial quantities of waste-water effluents which are contaminated with suspended solids, dissolved biodegradable chemicals, and trace amounts of inorganic chemicals from prior process operations.

Taken together, these aqueous effluents result in the pulp and paper industry's being one of the major water consuming industries and one of the major developers of water borne pollutants.

Waterborne pollution abatement procedures are being established throughout the industry as local and national regulations concerning the emissions of water-borne materials become more restrictive. The classical methods of pollution abatement technology, specifically primary and secondary biological treatment, find substantial utility in the separation of suspended matter and the reduction of BOD in aqueous effluents from the pulp and paper operations. Color pollution remains a substantial problem, and technology associated with color reduction is not yet universally applicable. High and low pH's are experienced in certain effluents, and their neutralization will be required in the near future. Temperatures can be controlled with recirculating tower systems. Dissolved inorganic solids will remain important water pollution problems for the foreseeable future until such time as tertiary treatment methods become economically acceptable to the industry.

C. MILL CHARACTERISTICS

1. General Traits

Mills vary widely in their physical characteristics, in part because of the regionality of the industry. In southern New England and upper New York State approximately 200 mills produce a wide variety of specialty papers and boards – ranging from tissue and fine papers for communications to special board materials such as shoe board. These mills, and the paper machines within them, are almost universally old, small and inefficient, some of which have resided in this area since

the founding of the industry in the 1800's. For the most part these operations rely on purchased pulps for their raw materials and upon high-quality products and high levels of customer service to achieve the selling prices necessary to sustain these businesses. The mills are usually low in net worth and seldom affiliated with the large corporations of the industry. As such, they represent the low end of the spectrum in their ability to deal with the pollution abatement investments and anticipated running costs.

In northern New England a sector of the industry has integrated pulp manufacture with papermaking but is characterized by antiquated facilities, low tonnage levels, and high wood costs. However, more of the manufacturing facilities in this sector have been recapitalized than in southern New England; thus this sector of the industry is better equipped to deal with pollution abatement than the southern New England and New York State areas. On the other hand, certain of the pulping operations in northern New England are of the sulfite variety, and substantial investments will be necessary in sulfite-pulp-mill liquor treatment systems (or alternatively, must be shut down) in addition to the biological systems required for the general treatment of aqueous mill effluents. Other mills are involved in kraft pulping, and new increments of investment in air pollution abatement in the kraft recovery systems will have to be implemented for these mills to continue in compliance with evolving air pollution regulations.

Although the northern New England sector of the industry will be better equipped to deal with pollution abatement than southern New England and New York, this is not to say that northern New England will have an easy time in complying with emission criteria. Ultimately these mills can expect substantial capital expenditures for this purpose, but for the most part they are owned by major pulp and paper concerns with the capital resources necessary to implement these investments.

The midwestern part of the country is comprised of a mixture of non-integrated paper mills such as are found in New York and southern New England, together with a group of integrated mills such as those in northern New England. The pollution abatement requirements of the Midwest (both for air control and reduction in water emissions) are not expected to be substantially different from those anticipated for the Northeast. Most mills in the Midwest will be faced with relative difficulty in solving their pollution problems. They are a mixture of independent organizations, some with pulping and some without, and a group of mills belonging to the major corporations of the industry where integration to pulping is usually possible. Here again, a number of sulfite pulp mills will require major capital investments for spent liquor treatment if they are to avoid being shut down.

In the southern kraft industry, integration to pulping is the rule rather than the exception. In addition, southern mills are more modern and represent substantially higher investments than is the case in the North. In addition, the southern kraft industry is probably more profitable than the northeastern industry and the midwestern industry, and is therefore better equipped financially to deal with air and water pollution abatement.

Most of the southern industry is located away from the metropolitan areas, whereas much of the northeastern and midwestern industry is located close to and even within city boundaries. It is also true that, for the most part, the mills of the southern kraft industry are owned by the major corporations whereas this is not universally the case in the Midwest and the North.

The West Coast mills are more typical of the southern kraft mills than the eastern mills in the sense that they are relatively new, usually integrated into pulping, and often owned by the major concerns of the industry. Notwithstanding this fact, some non-integrated independents in the Far West have pollution problems that will be as difficult to manage as those of some of their counterparts in the East and Midwest. In an overall sense, however, the western mills, with their relatively high levels of capital investment and cash flow, will be in a more secure position with respect to pollution abatement in the years ahead.

2. Mill Size Distribution

In general, mill size is a key indicator of economic viability with the smaller mills in each product sector being typically less profitable.

Figures 2-13 demonstrate mill size distribution throughout the United States in the various pulp, paper and board product categories.

For kraft pulp mills, the average size is 750 tons per day, for NSSC 250 tons per day, for sulfite about 150 tons per day and for de-ink pulp mills less than 100 tons.

In paper manufacture, the commodity products (such as newsprint and groundwood printing papers) range from 300 to 500 tons per day. This range also holds for the commodity board products such as linerboard and bleached food board. On the other hand, the specialty paper and board products (including fine papers, industrial papers, tissue, bogus boxboard, and construction materials) average 100 tons per day or less.

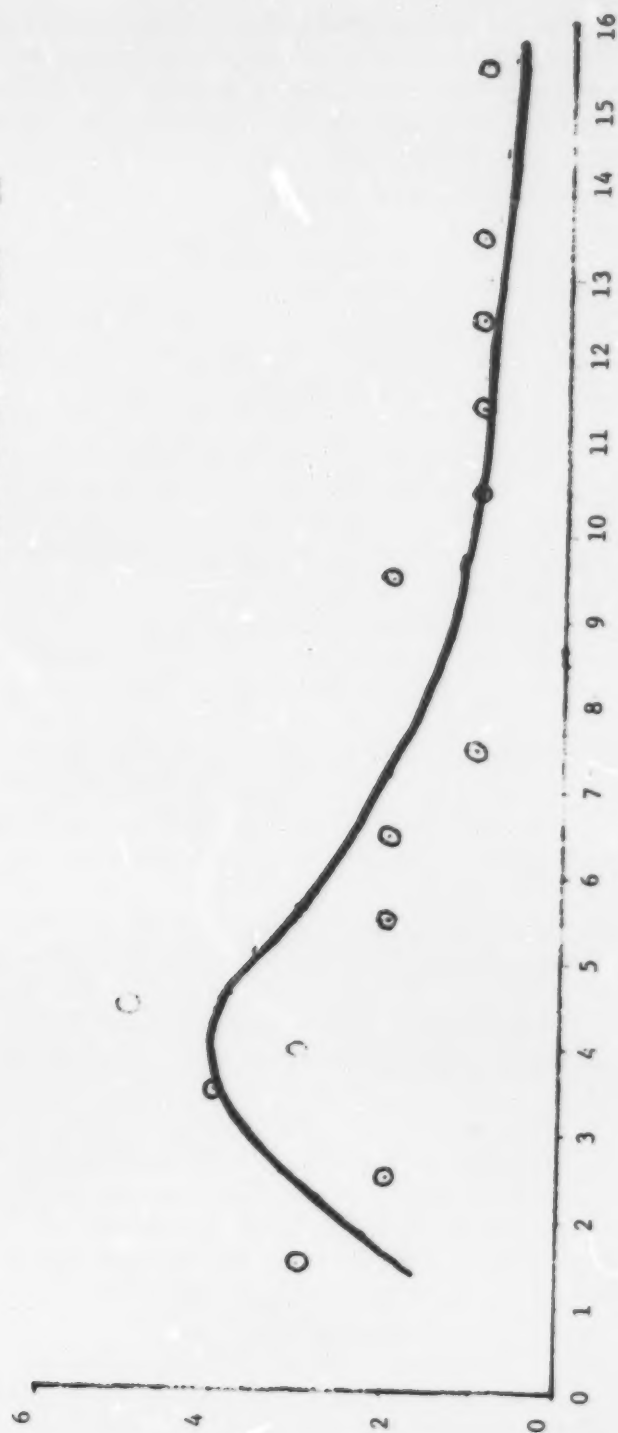
It is apparent that certain product sectors of the industry are subject to greater pressure with respect to the cost of pollution abatement because of throughput differences. The most exposed product sectors include the fine-paper

FIGURE 2

Size Distribution of U.S. Mills
For Production of
Newsprint and Uncoated Groundwood

Total Number of Mills: 32

Number of Mills in the U.S.

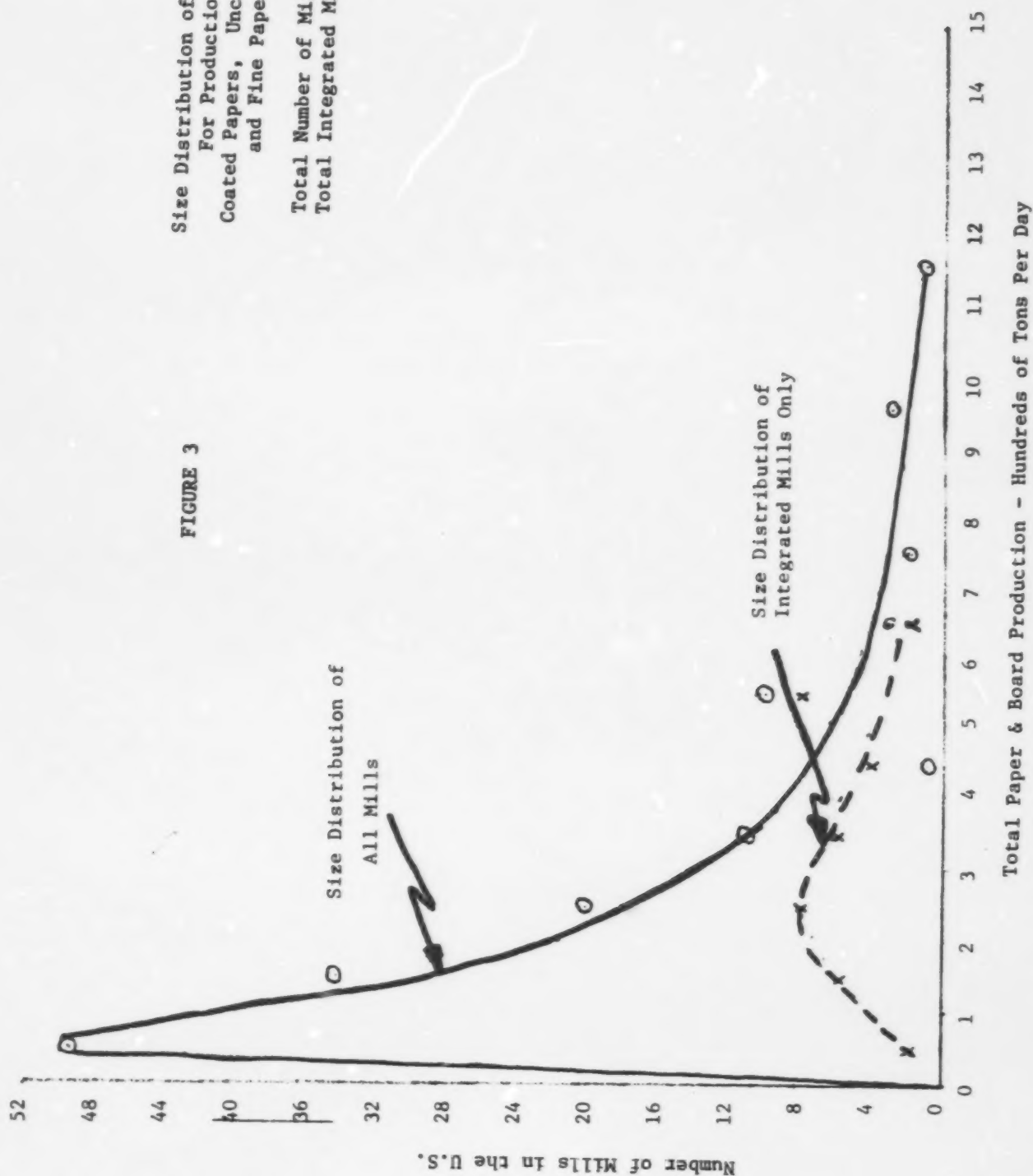


Total Paper Production - Hundreds of Tons Per Day

Size Distribution of U.S. Mills
For Production of
Coated Papers, Uncoated Book
and Fine Papers

Total Number of Mills: 134
Total Integrated Mills: 34

FIGURE 3

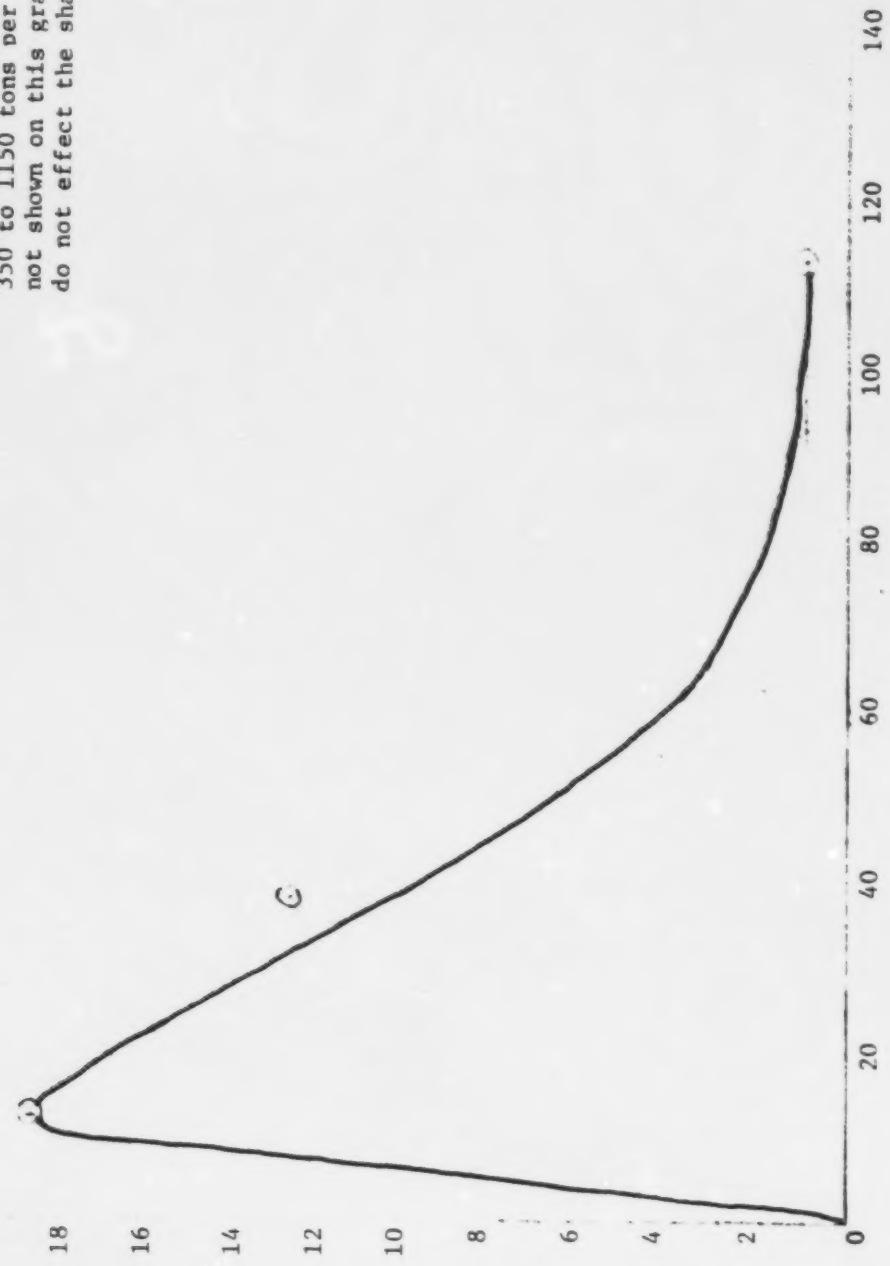


Size Distribution of U.S. Mills
For Production of
Special Industrial Papers

Total Number of Mills: * 36

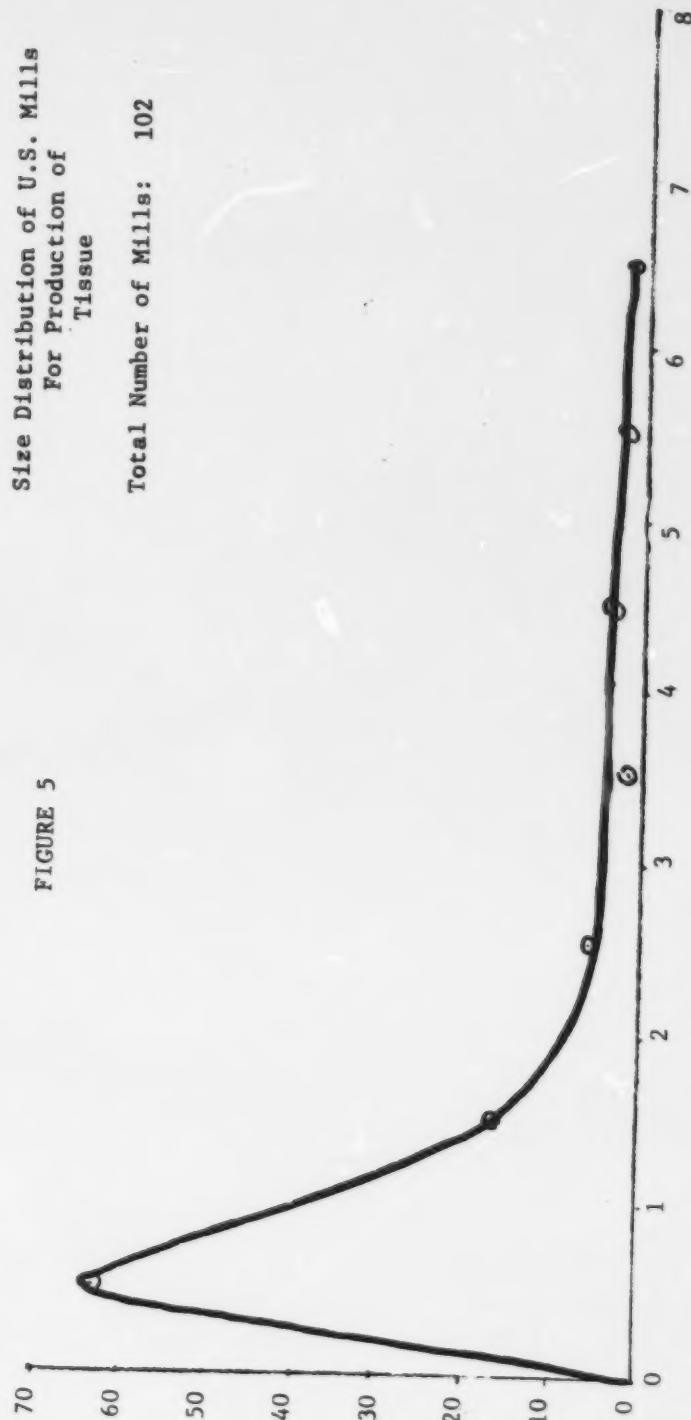
FIGURE 4

* There are several mills which list special industrial papers as one of a number of other grades produced. These mills have capacities from 350 to 1150 tons per day and are not shown on this graph since they do not effect the shape of the curve.



Number of Mills in the U.S.

Total Mill Production -- Tons Per Day

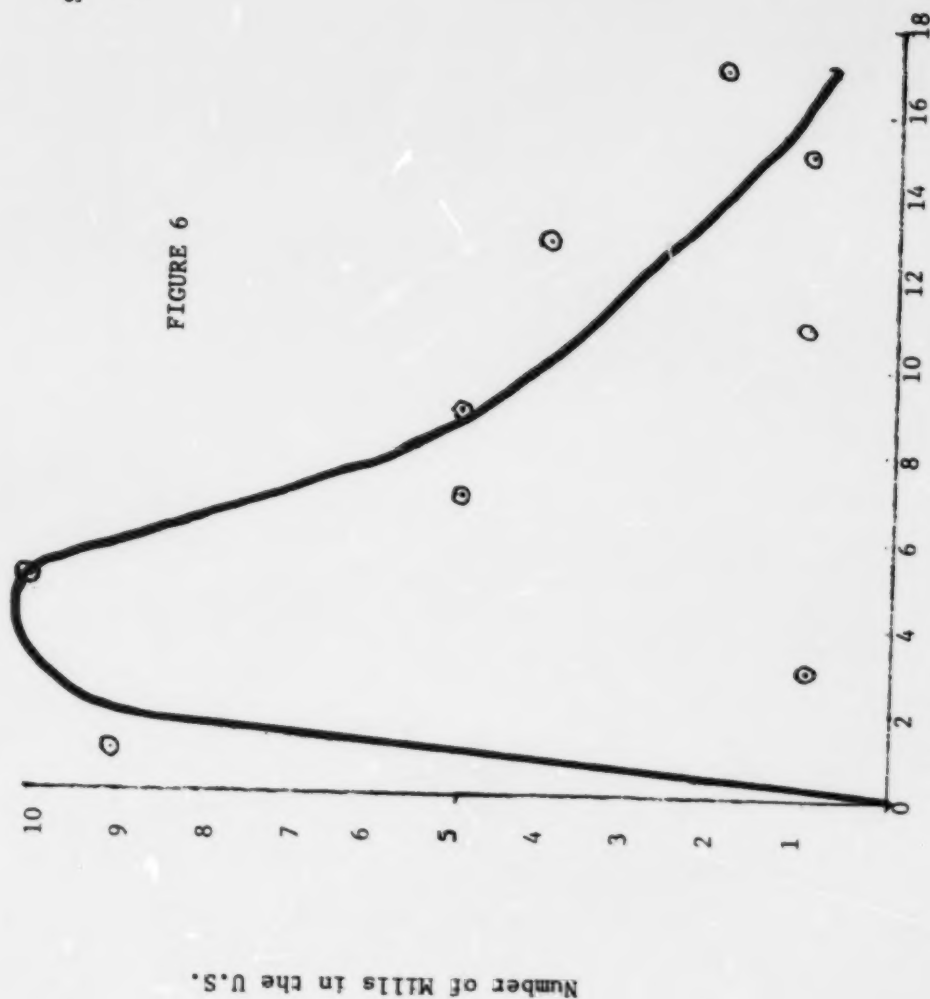


Number of Mills in the U.S.

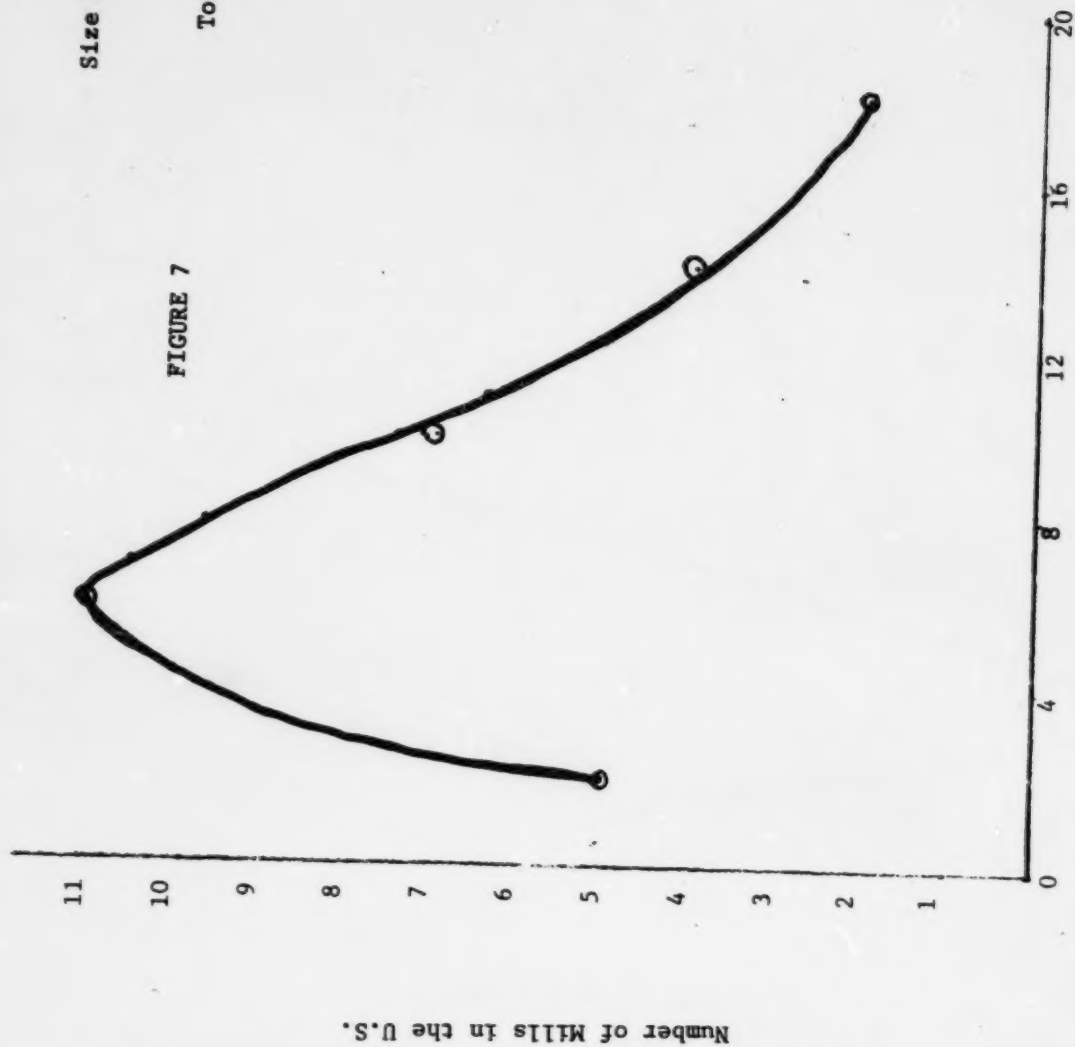
Total Papermill Production - Hundreds of Tons Per Day

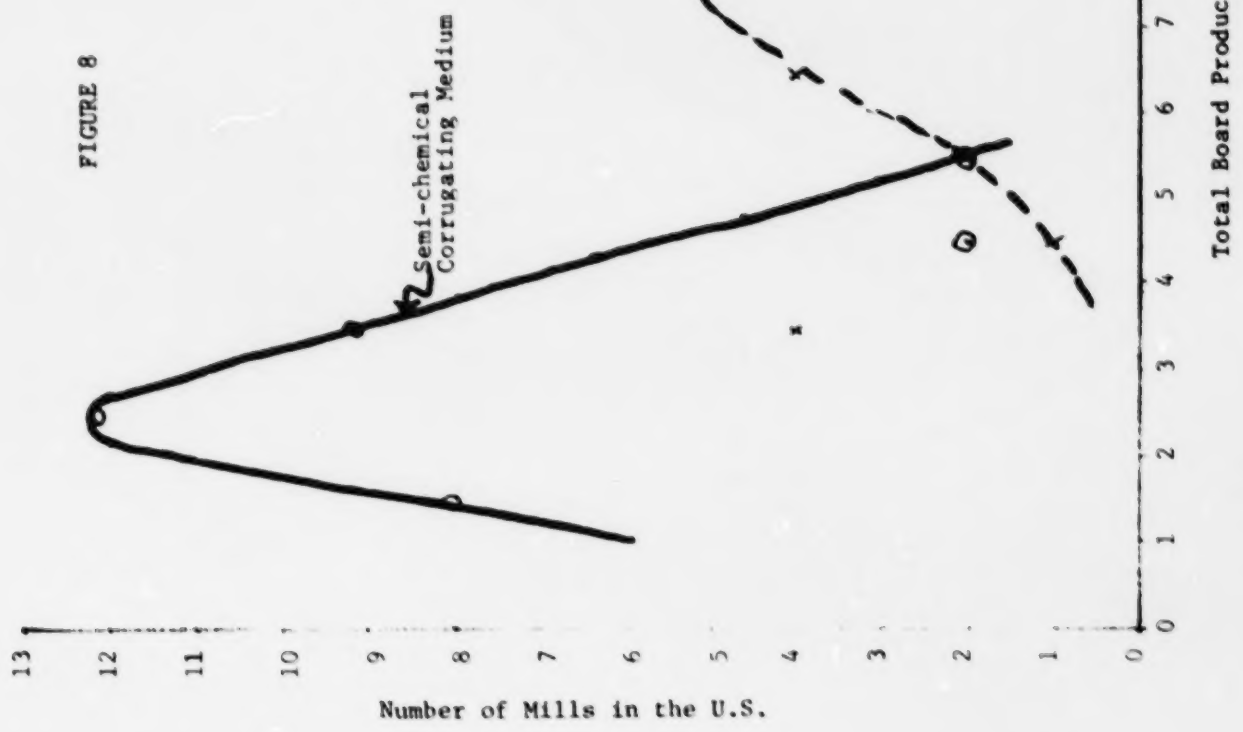
Size Distribution of U.S. Mills
For Production of
Unbleached Kraft Papers

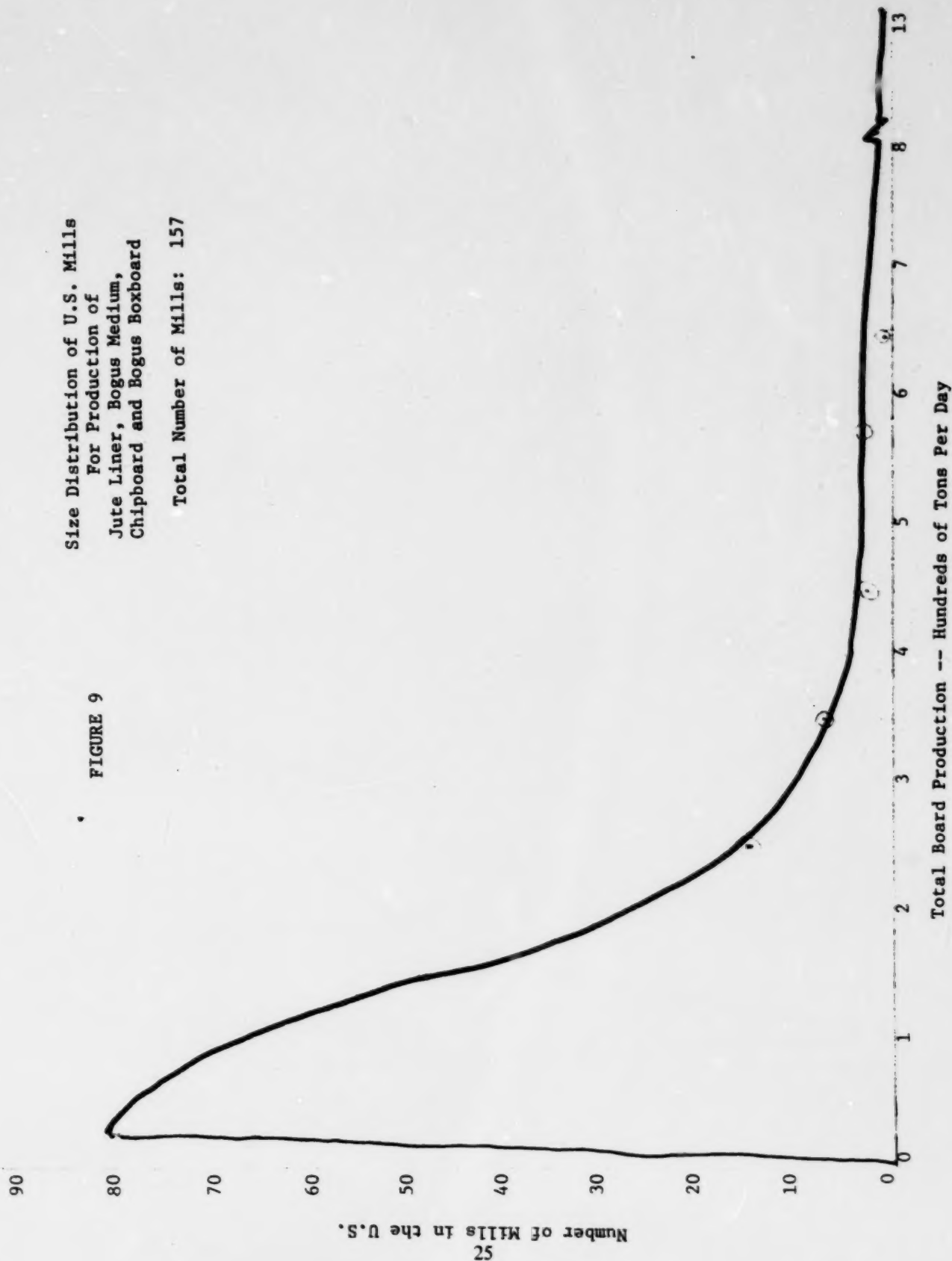
Total Number of Mills: 40



Total Paper Production - Hundreds of Tons Per Day

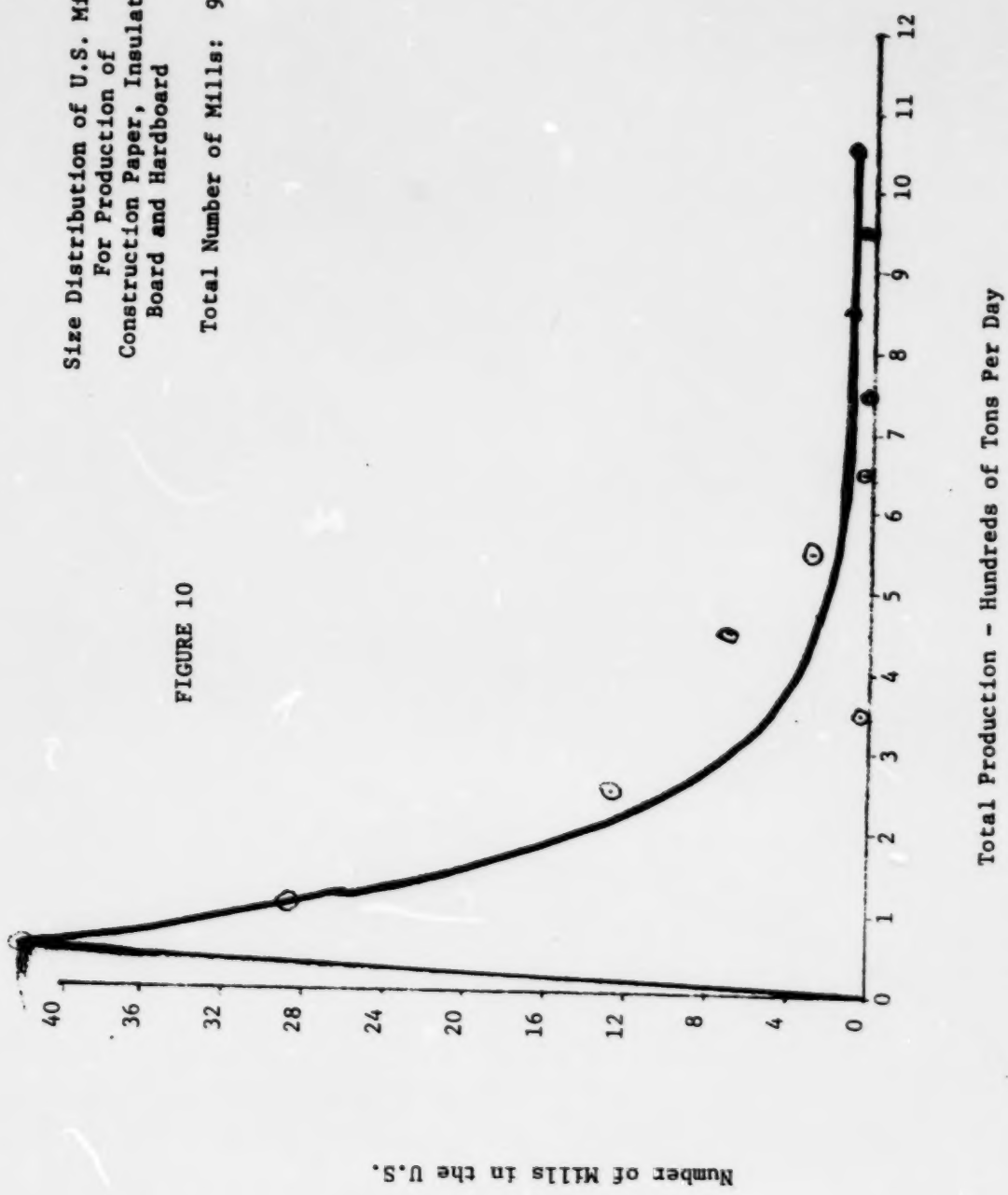






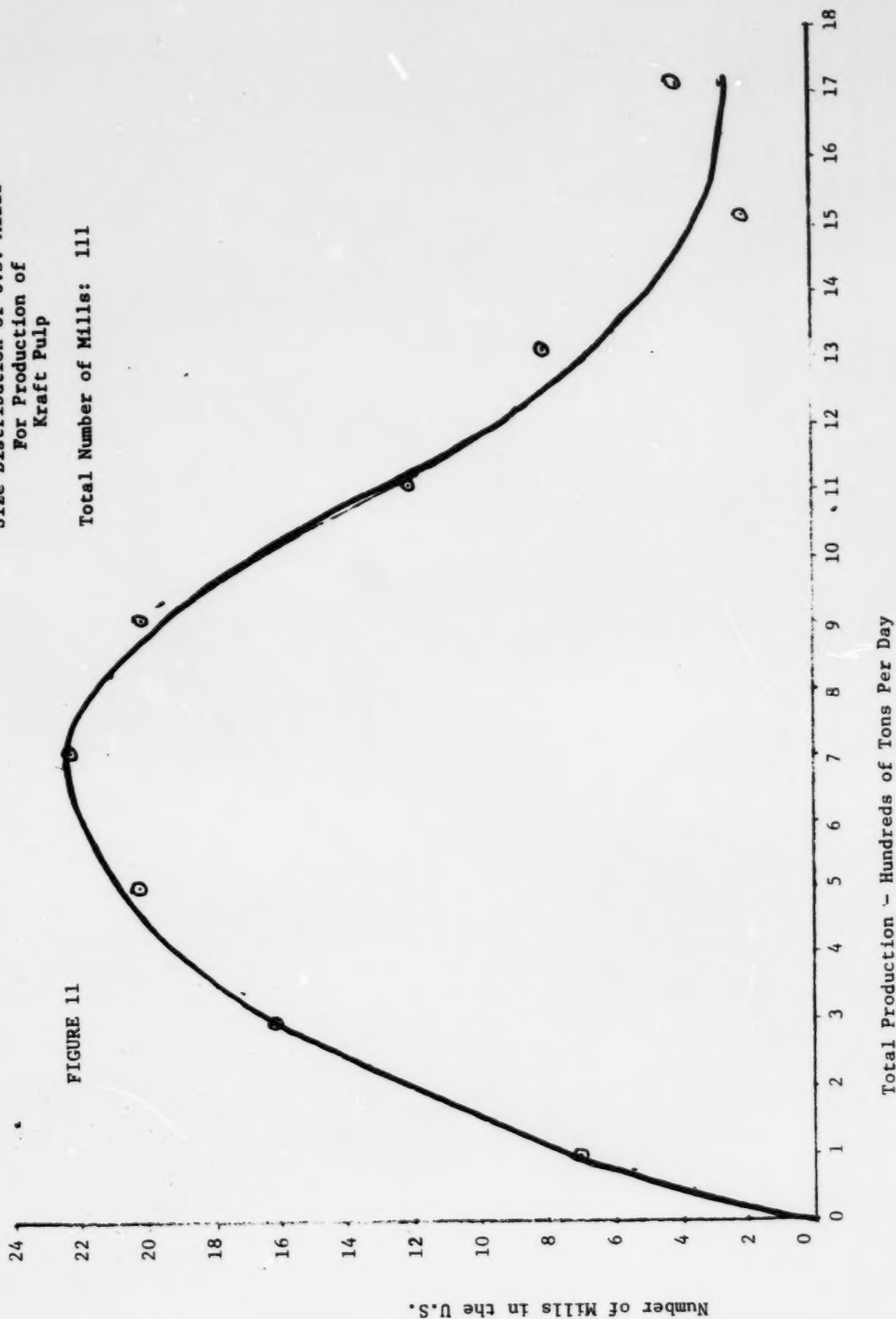
Size Distribution of U.S. Mills
For Production of
Construction Paper, Insulating
Board and Hardboard

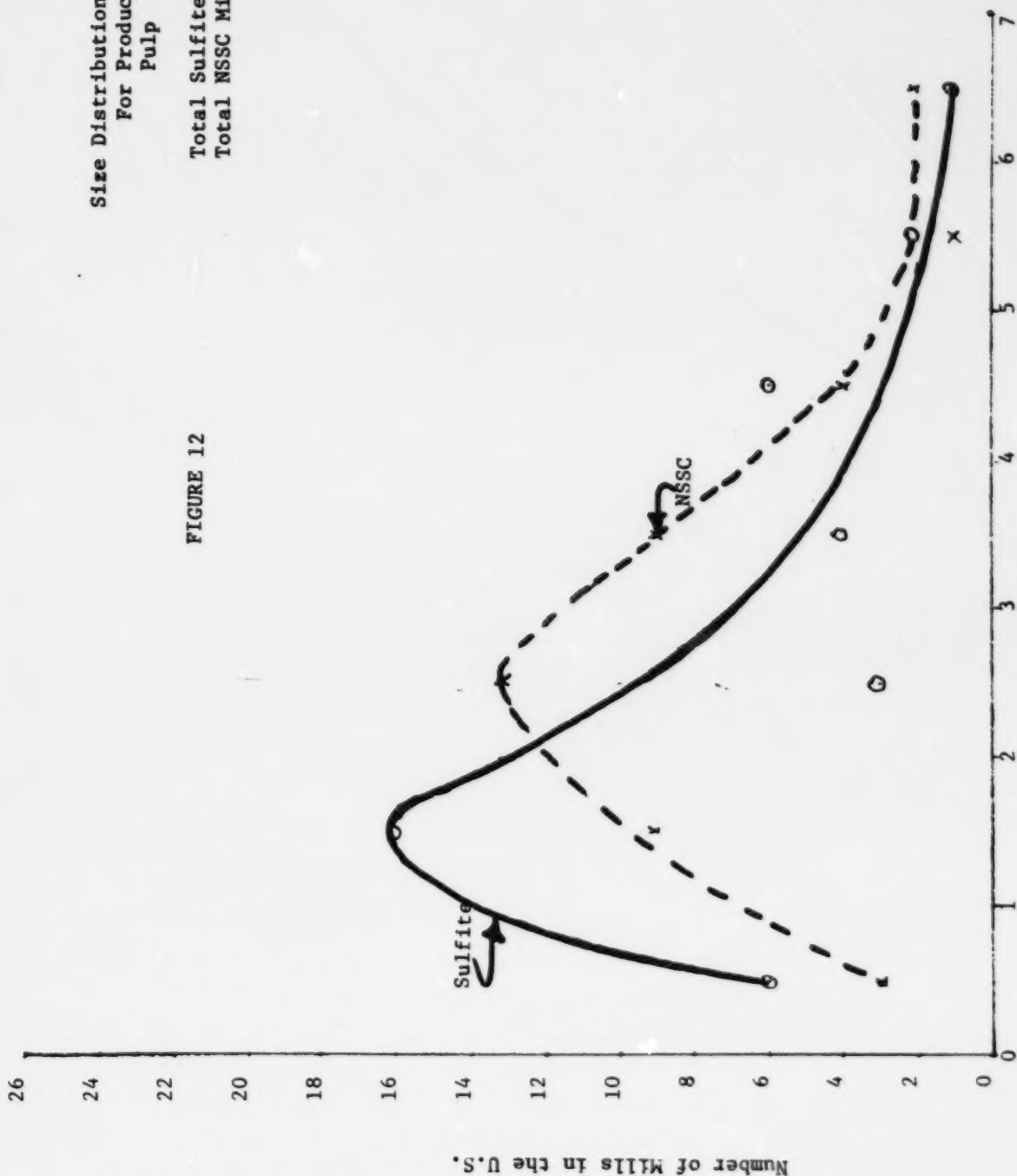
Total Number of Mills: 99

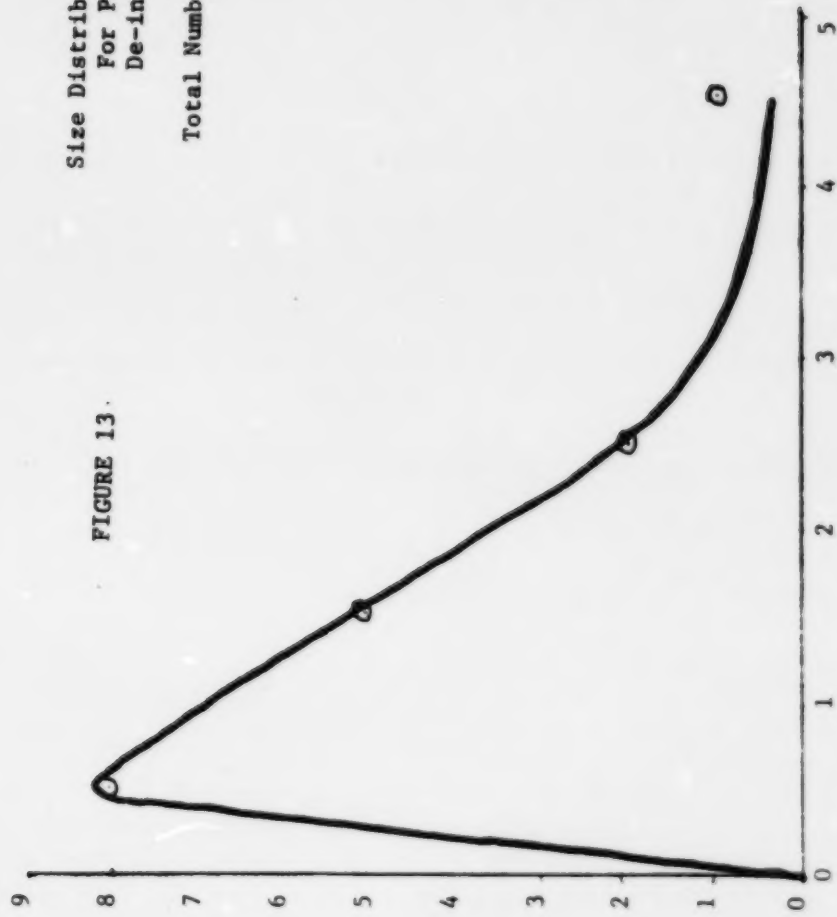


Size Distribution of U.S. Mills
For Production of
Kraft Pulp

Total Number of Mills: 111







Size Distribution of U.S. Mills
For Production of
De-ink Pulp Mills

Total Number of Mills: 16

Total Production - Hundreds of Tons Per Day

mills, the special industrial paper mills, the tissue mills, and the combination paperboard operations together with the wastepaper recovery and repulping operations which often accompany these papermaking activities.

3. Marginality Analysis

To obtain a preliminary assessment of the economic impact of pollution abatement, we grouped all the mills in the industry by major product categories and by regions. For each category and region we established judgment criteria as to what might constitute marginal economic mill operations and therefore suffer disproportionately with imposition of pollution abatement controls.

The judgment criteria included the following considerations:

- Size of mill with respect to a minimum economic size for each particular grade;
- Age of mill;
- Whether integrated to a pulp mill or non-integrated;
- Pulp mill process factors, such as a sulfite mill or NSSC mill without recovery, rag or de-inked plant without recovery or other known high-pollution load factors;
- Pollution abatement requirements relative to receiving water conditions;
- Whether integrated to subsequent converting operations;
- Product values;
- General market considerations;
- Raw material availability; and
- Management capabilities;

Each pulp, paper and board mill in the United States was then scrutinized against these criteria and, our judgment or specific knowledge, where applicable, was applied to categorize each mill as economically marginal or as better able to cope with increased pollution abatement requirements. Results of these judgments are shown in Table 1 by major paper and paperboard product groupings. Table 2 shows a summary by regions. Table 3 shows the results of our marginality analysis of sulfite pulp mills.

TABLE 1

ECONOMICALLY MARGINAL U.S. PAPER AND PAPERBOARD MILLS BY GRADE

	<u>Tons/Day</u>	<u>% of US</u>	<u>Marginal Mills</u>		
	<u>Total Capacity</u>		<u>Total</u>	<u>% of</u>	<u>% of</u>
	<u>Tons/Day</u>	<u>% of US</u>	<u>Mills</u>	<u>Mills</u>	<u>Capacity</u>
Newsprint + Uncoated Groundwood	14,800	100%	32	29%	19%
Printing, Writing + Related Papers:					
Non-integrated	7,120		75	95%	91%
Integrated to Pulp	<u>22,000</u>		<u>63</u>	<u>41%</u>	<u>32%</u>
Total	29,120	100%	138	70%	48%
Special Industrial	1,120	100%	36	25%	17%
Tissue:					
Non-integrated	5,365		72	68%	22%
Integrated to Pulp	<u>5,250</u>		<u>30</u>	<u>23%</u>	<u>13%</u>
Total	10,615	100%	102	48%	18%
Unbleached Kraft Paper]					
Unbleached Kraft Board]					
Bleached Packing Board]					
Semichemical Medium]					
Non-integrated	320		3	100%	100%
Integrated to Kraft Pulp	67,265		73	5%	1%
Integrated to NSSC Pulp	<u>6,575</u>		<u>21</u>	<u>48%</u>	<u>41%</u>
Total	74,160	100%	97	18%	5%
Combination Boxboard, Bogus + Jute + Wet Machine	24,655	100%	170	49%	27%
Construction Paper	5,535	100%	47	60%	36%
Hardboard	5,845	100%	29	35%	10%
Insulation Board	<u>5,600</u>	100%	<u>23</u>	<u>26%</u>	<u>9%</u>
TOTAL PAPER + BOARD	171,450		674	46%	18%

Sources: Arthur D. Little, Inc., mill data and estimates based on:
Lockwood's Directory of the Paper and Allied Trades, 1970
 (Lockwood Publishing Company, Inc., New York, 1969)
Post's 1971 Pulp and Paper Directory (Miller Freeman Publications,
 San Francisco, 1970)

TABLE 2

ECONOMICALLY MARGINAL PAPER AND PAPERBOARD CAPACITY BY REGION

<u>Region</u>	<u>Total Capacity</u>		<u>Total Mills</u>		<u>Marginal Mills</u>			
	<u>T/D</u>	<u>% US</u>	<u>No.</u>	<u>% US</u>	<u>In Region</u>		<u>Of Total US</u>	
					<u>% Mills</u>	<u>% Cap</u>	<u>% Mills</u>	<u>% Cap</u>
New England	15,485	10%	120	18%	69%	64%	12%	5%
Middle Atlantic	18,980	11%	133	20%	58%	33%	11%	3%
East North Central	28,535	17%	156	23%	48%	29%	11%	5%
West North Central	4,315	3%	21	3%	57%	36%	2%	<1%
South Atlantic	38,055	22%	69	10%	23%	3%	2%	<1%
East South Central	20,680	12%	46	7%	13%	2%	1%	<1%
West South Central	22,420	13%	44	6%	27%	5%	2%	<1%
West	<u>22,795</u>	<u>13%</u>	<u>84</u>	<u>12%</u>	25%	11%	<u>3%</u>	<u>1%</u>
Totals (rounded)	171,265	100%	673	100% (rounded)			44%	~18%

Sources: Arthur D. Little, Inc., mill data and estimates based on:
Lockwood's Directory of the Paper and Allied Trades, 1970
 (Lockwood Publishing Company, Inc., New York: 1969)
Post's 1971 Pulp and Paper Directory (Miller Freeman Publications,
 San Francisco: 1970)

TABLE 3

SULFITE PULP MILLSEstimate of % Economically Marginal

	<u>Total Mills</u>		<u>Marginal Mills</u>			
	<u>No.</u>	<u>tpd</u>	<u>No. % U.S.</u>	<u>tpd % U.S.</u>	<u>No. % Region</u>	<u>tpd % Region</u>
New England	5	1,370	25	33	60	33
Middle Atlantic	3	785	0	0	0	0
East North Central	11	1,525	42	35	45	32
West North Central	1	115	8	8	100	100
South Atlantic	1	400	0	0	0	0
East South Central	0	0	0	0	0	0
West South Central	0	0	0	0	0	0
West (incl. Alaska)	<u>16</u>	<u>5,555</u>	<u>25</u>	<u>24</u>	19	6
Total	37	9,750	100	100		

Sources: Arthur D. Little, Inc., mill data and estimates based on:
Lockwood's Directory of the Paper and Allied Trades, 1970 (Lockwood
Publishing Company, Inc., New York: 1969)
Post's 1971 Pulp and Paper Directory (Miller Freeman Publications,
San Francisco: 1970)

It is clear that most of the mills in potential economic trouble lie in the northeast quadrant of the United States. About 80% of all U.S. mills that are rated as marginal are found in New England, the Middle-Atlantic and the East-North-Central regions. These mills are generally the smaller and older ones, many of which are non-integrated paper mills largely producing printing, writing, and related papers, tissue, and special industrial papers. For example, we rated all of the non-integrated printing and fine paper mills in New England and over 80% in the other two regions as being in potential economic difficulty. Non-integrated tissue mills are in similar trouble, with about 80% of the mills in New England and around 50% in the other two regions appearing in the marginal category. It is equally clear that the large producing units in the southeast, south central and western regions are much more viable and will be able to better absorb pollution costs; typically the larger the mill, the lower the unit costs per ton of pulp.

It is interesting that about 48% of all U.S. mills were rated as marginal. These mills, however, represent only 19% of the total U.S. capacity. Again, this observation is indicative of the large number of small producing units now struggling for survival within the industry.

It should be pointed out that a substantial number of pulp mills, paper machines and integrated mills have been shut down during 1970 and 1971 for economic and/or pollution abatement reasons. For the most part these mills were small, inefficient units that produced printing-writing papers and combination paperboard. These mills have been excluded from our tabulations, but a number of operating units falling in the marginal classification are similar to them.

Outside of the printing and writing, tissue and combination paperboard grades indicated above, a key problem area is the semi-chemical pulp mills which are not equipped with a process to recover the NSSC spent liquor. Here, about 48% of the mills, about 40% of the total semi-chemical corrugating medium capacity, have substantial problems.

Clearly, many of the mills that we have placed in the marginal category will survive the economic and pollution abatement rigors of the industry. A number of smaller mills will maintain their position by astute application of new technology in the specialty paper field and survive with higher margin profits. Others will ride out the current recession and absorb their increased costs through higher prices as supply/demand balances improve. The judgment of what portion of this marginal production is likely to be shut down by 1976 because of the inability to bear additional pollution abatement costs will be the subject of our second report.

D. LABOR DISTRIBUTION

Table 4 shows our estimate of the employment distribution in the various industry products sectors.

On a regional basis, the northeastern part of the country represents about 35% of the total labor force utilized by the industry. The second largest labor area is the deep South, which produces principally unbleached kraft packaging papers and board along with bleached board and semi-chemical board and utilizes about 30% of the total labor demand of the industry. We expect the remaining labor (comprising approximately 35% of the entire industry) to be divided about equally between the Midwest and the Northwest.

TABLE 4

PULP AND PAPER INDUSTRY EMPLOYMENT, 1970

<u>Pulp, Paper and Paperboard</u>	<u>Total Employees</u>	<u>Percent of Total</u>	<u>Annual Tons/Employee</u>
Newsprint & Groundwood Printing Paper	18,000	5%	252
Printing, Book, Writing	81,000	21	107
Unbleached Kraft Packaging and Converting Paper	15,000	4	247
Bleached Packaging and Special Industrial Paper	12,000	3	137
Unbleached Kraft Board	15,000	4	753
Bleached Packaging Board	8,000	2	560
Semi-Chemical Board	5,000	1	698
Combination Board	45,000	12	155
Pulp Mills	58,000	15	727
Tissue (1)	100,000	25	36
Building Paper and Board Mills	<u>30,000</u>	<u>8</u>	138
Total	387,000	100%	

(1) Includes converting

Sources: Arthur D. Little, Inc., mill data and estimates based on:
Lockwood's Directory of the Paper and Allied Trades, 1970
 (Lockwood Publishing Company, Inc., New York: 1969)
Post's 1971 Pulp and Paper Directory (Miller Freeman Publications,
 San Francisco: 1970)

III. MARKET AND COMPETITIVE TRENDS

A. OVERVIEW

The paper industry to be viewed realistically, comprises a number of sub-industries built around major product groupings. To organize a supply/demand trend analysis, we have divided the industry into four major product groupings and three other product sectors. The four major product groups (each of which contain several grades) are: packaging paper and board (52% of the industry's current production tonnage); communication papers (25%); construction paper and board (7%); and market pulp (9%). Three product sectors account for the remaining 7%: tissue paper, special industrial paper, and wet machine board. To illustrate the composition and relative importance of each group Table 5 shows the 1970 production, import and export levels of the major product grades.

The only significant imported items are newsprint and market pulp, which constituted virtually all of the United States pulp and paper imports in 1970. Most of these imports come from Canada, which supplies about two-thirds of the United States demand for newsprint and for market pulp used primarily by non-integrated papermakers. These products are imported duty-free; hence they are not subject to the current import surcharge. Kraft paperboard and market pulp are the industry's largest export items; they account for 69% of its total exports in 1970. However, total exports amounted to only 10% of all United States production of pulp, paper, and board products. The major import and export items are products in which wood represents a significant portion of the total cost; North American producers will continue to have an advantage over foreign producers because of significantly lower wood costs on this continent. Our objective in this section is to analyze United States supply/demand trends; we will concentrate on the above items in determining export/import balances.

B. MARKET AND CAPACITY PROJECTIONS

Since operating rates are crucial to profitability in this capital intensive industry, we have projected United States production taking into account domestic consumption and significant export and import trends. The historical production statistics for this industry, reported regularly by the United States Department of Commerce, represent the basis for our growth projections. Rather than simply projecting these data, we have considered the overall growth rate of user industries; the extent of substitution of different pulp, paper, and board grades for each other; and the effect of competition from other products, such as plastics. We assumed the average GNP (constant dollars) growth rate to be 5%/year in 1972 and 1973. We assumed a decline thereafter, which would reflect an average growth of 4%/year between 1971 and 1976. This compares with a GNP growth of 3.9%/year from 1960 to 1970. We have also assumed there would be no

TABLE 5

U.S. PULP & PAPER MARKET STRUCTURE, 1970
(thousands of tons)

<u>GRADE</u>	<u>PRODUCTION</u>	<u>IMPORTS</u>	<u>EXPORTS</u>	<u>APPARENT CONSUMPTION</u>
<u>Packaging Paper and Board</u>				
Unbleached paper	3715	35	125	3625
Bleached paper	1237	39	14	1262
Unbleached kraft paperboard	11300	sm	1761	9539
Semi-chemical paperboard	3341	-	58	3283
Combination paperboard	6854	9	151	6712
Bleached paperboard	3465	-	129	3336
<u>Communication Paper</u>				
Newsprint	3356	6635	144	9847
Uncoated groundwood	1176	234	7	1403
Coated	3351	-	75	3276
Uncoated book and writing	5349	84	98	5335
Bleached bristols	1012	sm	-	1012
<u>Construction Paper and Board</u>				
Construction paper	1491	10	14	1487
Insulation board	1194	35	19	1210
Hard pressed board	1452	153	26	1579
<u>Other End-Products</u>				
Tissue and other creped	3611	sm	20	3591
Special industrial paper	408	sm	51	357
Wet machine board	158	9	5	162
<u>Pulp</u>				
Papermaking for market	3720	3235	2226	4729
Alpha and dissolving	1716	277	869	1124
TOTALS	57834	10745	5792	628 69

sm - small

Source: U.S. Department of Commerce

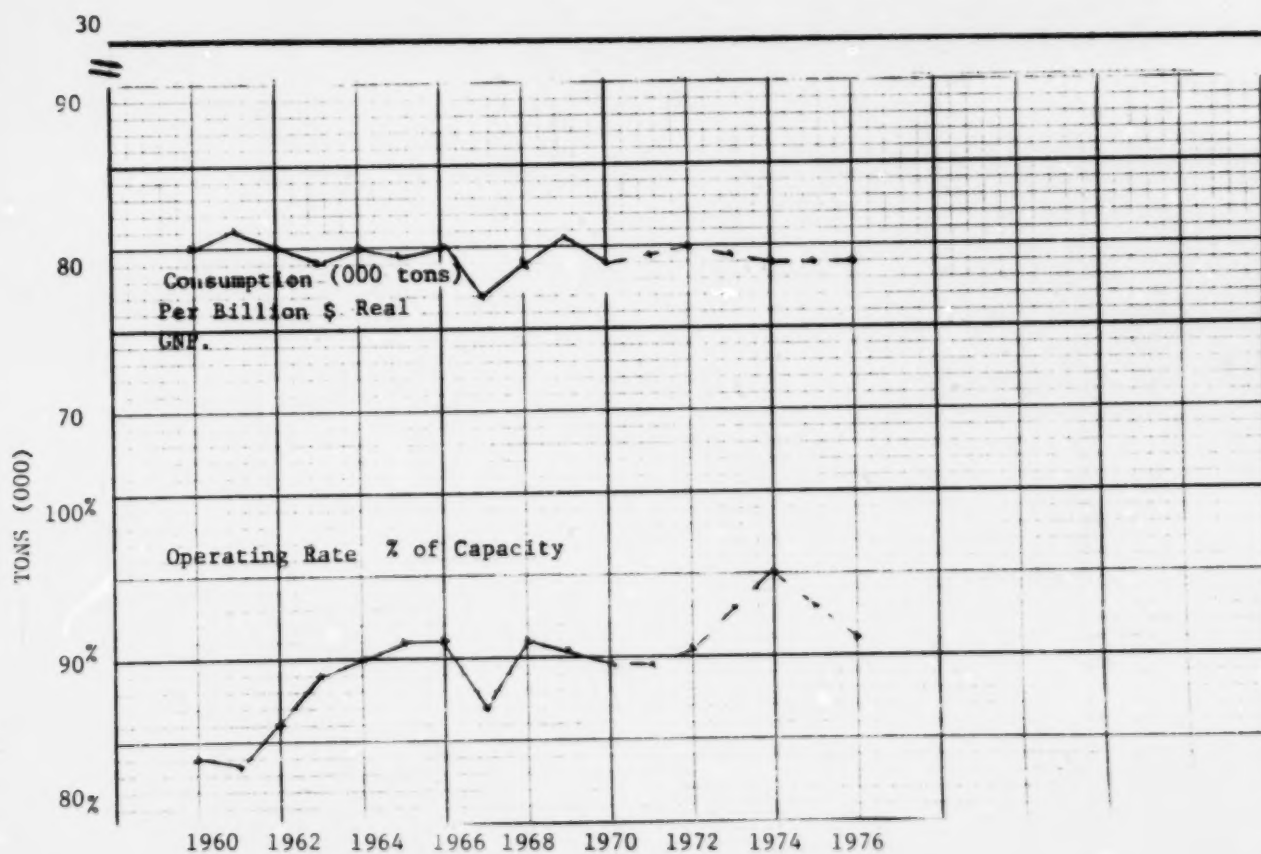
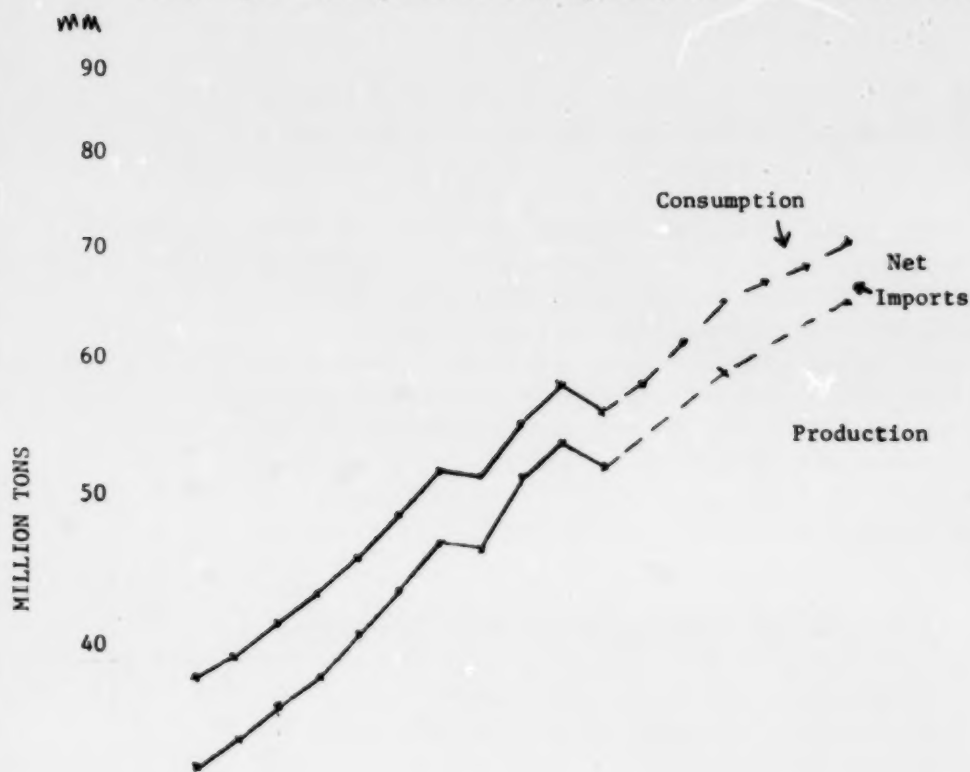
significant increases above current expenditures for air and water pollution abatement since our purpose is to illustrate a base case for the subsequent impact analysis.

To estimate future operating rates, we compared our market projections with the capacity expansion plans of the pulp and paper mills as reported to the American Paper Institute (API). These announcements usually reflect expansions scheduled to be on-stream about two years from the date of announcement; it takes about two years to put a paper or board mill on-stream once a firm commitment has been made. Because of continual improvements in reporting procedure we consider the API capacity figures to be reasonably accurate, for analyses of future operating rates (through 1973 in this case). In reviewing these analyses for most paper and board grades, a 95-96% annual operating rate represents a practical upper limit because of demand and capacity fluctuations during the year.

In general, the short range (1-2 years) demand for most of the industry's products is inelastic, or relatively insensitive to price changes. Few substitute products compete directly with paper, the key exceptions being plastics in certain packaging markets, wood products in certain construction applications, and textiles in many tissue paper markets. Also, even where substitute items exist it takes some time and capital investment to allow the intermediate processors or converters to change their equipment and procedures to adapt to substitute materials. Finally, direct or indirect expenditures on paper products represent a small portion of the consumer's total disposable personal income. Unfortunately it is difficult to demonstrate demand inelasticity numerically since there have been only modest price increases over the past decade. We will note, however, those product areas where price changes or relative stability appear to have had the effect of slowing or increasing demand.

Overall, total paper and paperboard consumption has maintained close correlation with real GNP. This should be true at least through 1976, because of the widespread use of paper and paperboard products throughout the economy. This total consumption forecast coupled with the expected changes in our net import tonnage provided the basis for our production and operating rate projections shown in Figure 14. This analysis indicates a solidification of industry operating rates from a slack situation in 1971 to an extremely tight supply/demand balance in 1974. Our examination of past cycles indicates that operating rates will probably decline again between 1974 and 1976. Operating rates will vary considerably by product group, as shown below.

Figure 14
Total Paper and Paperboard Consumption, Production and Operating Rate Trends



1. Packaging Paper and Board

Our projections for packaging paper and board supply/demand balances are summarized in Table 6.

Unbleached kraft paperboard, the largest volume packaging grade, consists primarily of linerboard which forms the outer facing of corrugated shipping containers. About 90% of United States production is consumed by box plants owned by linerboard producers. We expect domestic consumption to taper off somewhat from the 7%/year rate achieved in the 1960's. This will reflect the current economic slowdown, the declaration of the Indo-Chinese conflict, and modest displacement of corrugated containers by plastic film overwrap containers. Export growth will also slow down, because of an expected temporary slackening of world economic growth; exports will still maintain higher growth than domestic consumption. United States linerboard suppliers are in a favorable export position because they have cheaper wood and larger, more efficient mills than producers in Scandinavia, Russia, and Canada – the only other major softwood producing regions. Unbleached kraft board is made predominantly from softwood, which is still abundant in North America. Southern U.S. pine is better suited for this product than Canada's softwood species. Russia's softwood resources, although abundant, are in a geographically remote region (Siberia); transportation lines have not been developed to handle large export tonnage economically. Also, per capita consumption of paperboard in the Soviet Union is low but expected to rise rapidly; domestic demand will have to be met before export markets are pursued. Finally, east-west trade barriers will continue to impede exports from Russia. Our analysis indicates a significant tightening of the United States supply/demand balance by 1973 to an operating rate of 96% – the practical upper limit for this sector.

Semi-chemical paperboard, used for the inner fluting of corrugated containers, is expected to grow faster than domestic corrugated box consumption, because the market share held by fluting made from wastepaper has been continually displaced. There is a high degree of interest in recycling wastepaper, and we believe that this factor will increase the amount of recycled fiber used in corrugating medium. On the other hand, 100% recycled corrugating medium has inferior strength properties and growth of the semi-chemical product will be stimulated by continuing overcapacity and hence weak prices. This is one of the few sectors in which operating rates are expected to remain weak through 1973. The export potential for this product is minimal. It is made primarily from hardwoods which are abundant throughout most of the world; thus it is usually produced close to the market.

TABLE 6

PACKAGING PAPER AND BOARD - U.S. PRODUCTION AND CAPACITY, 1960-76

<u>GRADE</u>	(thousands of tons)				Avg. Annual Growth (%)	
	<u>1960</u>	<u>1970</u>	<u>1973</u>	<u>1976</u>	<u>1960-70</u>	<u>1970-76</u>
<u>Unbleached Kraft Board</u>						
Domestic Consumption	4805	9539	11000	12200	7.1	4.2
Exports	381	1761	2200	2800	16.2	8.0
Total Production	5186	11300	13200	15000	8.1	5.0
Capacity		12307	13708			
Operating Rate (%)		92	96			
<u>Semi-Chemical Board</u>						
Production	1736	3341	4000	4600	6.8	5.5
Capacity		3756	4594			
Operating Rate (%)		89	87			
<u>Combination Board</u>						
Production	7017	6983	7800	8300	-	3.0
Capacity		8084	8267			
Operating Rate (%)		86	94			
<u>Bleached Paperboard</u>						
Production	1746	3466	3800	4300	7.1	3.5
Capacity		3472	3807			
Operating Rate (%)		100	100			
<u>Unbleached Kraft Paper</u>						
Production	2961	3715	3900	4400	2.3	3.0
Capacity		4070	4001			
Operating Rate (%)		91	97			
<u>Bleached & Other Paper</u>						
Production	996	1237	1270	1350	2.3	1.5
Capacity		1316	1291			
Operating Rate (%)		94	99			

Sources: U.S. Department of Commerce (past production)
 American Paper Institute (year end capacities)
 Arthur D. Little, Inc. (production forecasts)

Combination paperboard — used primarily in folding cartons and set-up boxes — has been hard hit by competition from plastics, thin-walled corrugated containers, and bleached folding boxboard. This sector has also faced rising costs for reclaimed paper, because the high labor cost component in reclamation has increased faster than the cost of virgin wood fiber. However, we believe that the concern about solid waste disposal and reclamation will revitalize the growth of this sector because the paper raw material which it uses can be reclaimed much more easily than plastics; also the product uses far less virgin pulp than the solid fiber paperboard products with which it competes. The Federal government will probably have a significant influence in stimulating this growth by changing its purchasing specifications and by encouraging the states to change their requirements for the packaging materials used in the products which they purchase. Our estimate of future demand indicates that the operating rate will increase to 94% of capacity by 1973 in this sector. However, we are more uncertain about the actual growth to be achieved here than we are about other product sectors. If only a 1%/year growth is achieved, there will be no operating rate improvement through 1973 other than from attrition of existing mills.

Competition from plastics and retardation in the displacement of combination paperboard in folding cartons should cause a decline in the growth rate of *bleached paperboard*. Bleached board is being displaced by molded plastic containers in some of its key markets, i.e., milk cartons, ice cream containers, and cups. Capacity figures for this sector are suspect because monthly fluctuations in demand make it infeasible to operate at 100%. Indeed there is a great deal of flexibility in producing bleached bristols or simply drying pulp on these machines. However, since producers in this sector are mostly vertically integrated to the market and since the export potential is relatively low, the producers have been able to keep capacity in line with demand in recent years and should continue to do so through 1973.

Unbleached kraft paper — used primarily in paper shipping sacks and grocery sacks — has faced strong competition from plastic film and bags, particularly in the multi-wall bag sector. This competition plus a gradual trend to bulk shipments has contributed to the low growth rate of this product during the 1960's. We expect the growth to improve somewhat through 1976 because of the disposal problems associated with plastic bags, and because paper bags are being used more for refuse disposal since they are biodegradable or can be cleanly burned. This increased growth combined with a modest capacity reduction should improve significantly the operating rate in the sector by 1973.

Bleached and other packaging paper includes bleached bag and sack paper, glassine and greaseproof papers. This sector suffers more than the unbleached kraft paper sector from competition with plastic film because of the relatively higher cost and demand-price elasticity of bleached papers and glassine. We expect

the growth rate of this sector to decline somewhat below the rate achieved in the 1960's. Nevertheless since no additional capacity is planned for this sector through 1973, its operating rate should become extremely tight during that year.

2. Communication Paper

Table 7 shows our supply/demand projections for the various communication paper grades.

We forecast the continuation of the growth trends of the 1960's for domestic consumption, net imports, and United States production of *newsprint and uncoated groundwood papers*. The increasing market share of domestic suppliers is due mainly to continued expansion of large efficient newsprint mills in the south. Most of the imports are from Canada; Canada has expanded its newsprint output even more rapidly than United States producers, but is directing much of its increased production to overseas markets. North American producers have a favorable export position in newsprint because they have large, efficient mills, and their softwood costs are relatively low.

We forecast a slowing of the growth rate of *coated papers* because of reduced substitution of coated papers for uncoated printing papers and slower growth in the magazine industry — a key market. The slow growth in magazines stems from a trend toward use of lighter weight papers to offset rising postal costs and from continued displacement of magazine advertising by television media. Other markets (particularly books and general commercial printing) should show good growth. There is relatively little new capacity planned for this sector; the operating rates should improve significantly by 1973.

The printing and business forms industries are both sluggish, because of the economic recession. Consequently, we forecast a rate of growth slower than that of the 1960's for *uncoated book and writing papers*. However, there has been a commensurate slowdown in capacity expansions. The operating rate for this sector should improve significantly by 1973 as growth is restored with the pick-up in the general economy.

Our significantly lower forecast growth for *bleached bristols* as compared to the historical trend is based on the static outlook for tabulating card stock, which is one of the largest components of this sector. Tabulating cards, which experienced a high growth rate during the 1960's, are now being displaced by magnetic tape and optical scanners for computer input/output. The operating rate in this sector, however, should improve significantly by 1973 because other bristol applications (file folders and index cards) are growing and a slow rate of capacity expansion is planned.

TABLE 7

COMMUNICATION PAPER - U.S. PRODUCTION AND CAPACITY 1960-1976

<u>GRADE</u>	(thousands of tons)				Avg. Annual Growth (%)	
	<u>1960</u>	<u>1970</u>	<u>1973</u>	<u>1976</u>	<u>1960-70</u>	<u>1970-76</u>
<u>News & Uncoated Groundwood</u>						
Domestic Consumption	8248	11250	12300	13400	3.1	3.0
Net Imports	5305	6690	7400	7700	2.4	2.5
U.S. Production	2941	4522	4900	5700	4.4	4.5
Capacity		4690	5018			
Operating Rate (%)		96	98			
<u>Coated Paper</u>						
Production	2125	3351	3800	4200	4.6	4.0
Capacity		3700	3901			
Operating Rate (%)		91	97			
<u>Uncoated Book Writing & Related</u>						
Production	3288	5349	6300	6900	5.0	4.5
Capacity		6177	6616			
Operating Rate (%)		87	95			
<u>Bleached Bristols</u>						
Production	603	1012	1100	1200	5.3	3.0
Capacity		1112	1123			
Operating Rate (%)		91	98			

Sources: U.S. Department of Commerce (past production)
 American Paper Institute (year end capacities)
 Arthur D. Little, Inc. (production forecasts)

3. Construction Paper and Board

Underlying our projections of construction paper and board grades is the basic growth outlook for the construction industry. Using 1970 as the base year, we have projected construction unit growth to 1976 at 8.5%/year (residential), 4%/year (non-residential) and 5%/year (remodeling). Most of the residential construction growth will occur in the early part of the forecast period; we project housing starts of 2.4 million units in 1976 as compared to an estimated 1.95 million units in 1971 and 1.45 million in 1970. Our projections for the various construction paper and board grades are summarized in Table 8.

Construction paper used in residential construction and remodeling will benefit directly from the substantial growth forecast for these activities. However, there will be some displacement of construction paper with expanded use of wall-to-wall carpeting and tile floors as a substitute for hardwood floors, which require the use of construction paper. Our growth forecast indicates a significant improvement in the operating rate for this sector although it will still have some slack capacity in 1973.

Approximately 50% of domestic *hardboard* consumption is distributed in construction; 20% is in furniture and cabinets; 30% is in miscellaneous uses. Its high growth in the 1960's is attributed mainly to substitution of printed hardboard for hardwood veneer in wall panels and furniture. While this trend will continue, we expect somewhat lower growth rates in consumption, averaging 7% per year through 1976. This decline from the historical growth rate of 7.6%/year will be caused by increasing competition from particleboard and medium density fiberboard in thicker products. Domestic suppliers will face continued competition from imports. Imports as a percent of domestic hardboard consumption have fluctuated between 10 and 18% during the last decade; they accounted for 10% in 1970. Assuming a lifting of the current import surcharge, we believe that imports will recapture a 15% share of the United States consumption by 1976. United States tariffs on most unfinished hardboards will remain at 7.5%; tariffs on some unfinished hardboards will drop from 11-12% in 1970 to 7.5% in 1972. The previous 19% tariff on surface-finished hardboard will drop to 15% in 1972 under the GATA agreement. Hardboard can be produced economically in tropical countries because the dense hardwoods and hardwood residue available make an excellent product without resin. The production process uses high temperature and pressure to bind the wood fibers by fusing the natural lignin of the cell walls. Hardboard is a denser, higher-value-added product than either particleboard or insulation board; it is better able to absorb transportation costs. The net result of product substitutions and increasing competition from imports will be that domestic production growth will be considerably lower than the rate achieved during the 1960's. Nevertheless, the operating rate of this sector should maintain the high level it achieved in 1970 through 1973.

TABLE 8

CONSTRUCTION PAPER & BOARD - U.S. PRODUCTION AND CAPACITY, 1960-1976

(thousands of tons)

<u>GRADE</u>	<u>1960</u>	<u>1970</u>	<u>1973</u>	<u>1976</u>	<u>Avg. Annual Growth (%)</u>	
					<u>1960-70</u>	<u>1970-76</u>
<u>CONSTRUCTION PAPER</u>						
Production	1410	1491	1900	2100	0.5	6
Capacity		2042	2148			
Operating Rate (%)		73	89			
<u>HARD BOARD</u>						
Domestic Consumption	761	1579	2150	2400	7.6	7
Net Imports	75	127	300	300	5.4	15
Production	686	1452	1950	2100	7.8	5.5
Capacity		1597	1938			
Operating Rate (%)		95	97			
<u>INSULATION BOARD</u>						
Production	1097	1194	1400	1200	0.9	-
Capacity		1721	1813			
Operating Rate (%)		70	77			

Sources: U.S. Department of Commerce (Past production)
 American Paper Institute (Year end capacities)
 Arthur D. Little, Inc. (Production forecasts)

Insulation board is used primarily for interior wall board and ceiling tile. Growth in the United States demand over the past 10 years has been less than 1% per year; demand is expected to remain relatively static through 1976. Output should reach a peak by 1973, due to the near-term acceleration of construction activity. Beyond 1973 the industry will have difficulty maintaining its current output level as building codes requiring the use of sheathing are eliminated; as fire codes become increasingly stringent; and as alternative sound-deadening materials, particularly plastic foams, become more widely used. Insulation board imports will remain negligible. On balance we expect continued overcapacity.

4. Other End-Product Sectors

The other major end-product sectors of the paper industry are tissue paper, special industrial papers, and wet machine board. Our projections of growth and operating rates in these categories are shown in Table 9.

Tissue paper, which includes toilet tissue, napkins, towels, and facial tissue is the largest consumer category in the pulp and paper industry. The growth of tissue products has been slowing over the past five years because they are not being as readily substituted for textiles. However, we expect that they will maintain an average growth of 4.5%/year from 1970 to 1976. The demand for non-woven disposable products will contribute to this growth. Non-wovens now represent a very small portion of the total volume of tissue papers, but they are projected to increase at about 15-20%/year. Without the bolstering effect of disposables, the tissue sector's growth rate would continue to decline, as displacement of cloth products by paper products runs its course. Based on this analysis, operating rates should improve significantly in this sector through 1973.

The *special industrial paper* sector contains various grades whose properties are specific to technical applications. These products include cable wrapping paper, filter paper, sandpaper backing, and paper and resin impregnating stock. Because of the widespread industrial applications for these grades, their growth depends on that of the overall economy. Exports should grow at a higher rate than domestic consumption, due to the relatively higher economic growth rate in other parts of the world that will continue to rely on the technical know-how and scale economies of United States producers. On the basis of our production forecast, the operating rate for this sector should improve considerably through 1973; still it will be only about 80% in that year.

The *wet machine board* sector consists primarily of shoe board; it also includes products such as automotive board, chair seat backing, and electrical insulation board. Growth has been static during the 1960's, because the United States shoe industry has declined and plastic composition materials have been substituted for wet machine board in a number of applications. We expect this

TABLE 9

TISSUE, SPECIAL INDUSTRIAL PAPER & WET MACHINE BOARD
U.S. PRODUCTION AND CAPACITY 1960-1976

(thousands of tons)

<u>GRADE</u>	<u>1960</u>	<u>1970</u>	<u>1973</u>	<u>1976</u>	<u>Avg. Annual Growth (%)</u>	
					<u>1960-70</u>	<u>1970-76</u>
<u>TISSUE & OTHER CREPED</u>						
Production	2201	3611	4200	4700	5.1	4.5
Capacity		4185	4492			
Operating Rate (%)		86	93			
<u>SPECIAL INDUSTRIAL PAPER</u>						
Domestic Consumption	254	358	410	450	3.5	3.8
Net Exports	29	50	60	70	5.6	5.5
Production	283	408	470	520	3.7	4.0
Capacity		554	583			
Operating Rate (%)		74	81			
<u>WET MACHINE BOARD</u>						
Production	175	158	160	160	-	-
Capacity		166	175			
Operating Rate (%)		95	92			

Sources: U.S. Department of Commerce (Past production)
 American Paper Institute (Year end capacities)
 Arthur D. Little, Inc. (Production forecasts)

situation to continue through 1976. Because capacity has been expanded modestly in the face of static demand, the operating rate for this sector should decline through 1973, as compared to the relatively high level attained in 1970.

5. Market Pulp

Market pulps are intermediate products which consist of papermaking pulp grades and dissolving pulp. Papermaking grades are used to supply the fiber needs of non-integrated paper mills and to balance the pulp needs of integrated producers. There is also substantial world trade of market pulp to fill regional imbalances. In this analysis we have emphasized *bleached sulphate or kraft* pulps, which is by far the most important grade of market pulp. *Dissolving pulp*, which is a special category of bleached chemical pulp, is more similar to a chemical raw material than the other pulps produced by the paper industry. Its principal applications are in rayon-acetate textile fibers, cellophane, and cellulose ester plastics. Table 10 presents our production, trade, and capacity projections for these two types of pulp.

A long-term forecast of United States bleached kraft pulp production is bound to be uncertain, because exports and imports exert a great influence, and because world trade patterns are always difficult to project. We have based our United States import/export forecast on our worldwide supply/demand forecast for all grades of bleached pulp (including market and integrated pulp) through 1973. This reflects the continued displacement of sulphite pulp by kraft pulp, which is due to the severe water pollution problem and cost/property disadvantages associated with sulphite pulp. Our analysis reveals an average growth in demand of 8%/year for kraft pulp from 1969 to 1973 as compared to a growth in capacity of 7%/year. These trends will lead to a significant tightening of world operating rates in 1973. The maximum operating rate which this industry is able to achieve in a full year is 96% because of demand fluctuations; we do not expect this practical maximum to be exceeded in 1973, because there is still an opportunity to add capacity beyond the expansions reported to the various associations.

Also, there will be an excess of capacity in Canada and a dearth in the United States. Therefore, we have projected a significant retardation in the growth of United States exports and a rapid increase in imports particularly through 1973, as shown in Table 10. The forecast slowing domestic consumption rate will be caused mainly by the price elasticity of demand. We expect significant price increases in bleached kraft pulp by 1973, because the world supply/demand balance is tightening. This factor will retard the displacement rate of sulphite pulp and will stimulate greater use of deinked waste paper as a pulp substitute. It will also create a cost-price squeeze for paper producers who are not integrated to pulp.

TABLE 10

BLEACHED KRAFT AND DISSOLVING PULPS - U.S. PRODUCTION AND CAPACITY, 1960-1970

(thousands of tons)

	Avg. Annual Growth (%)					
<u>GRADE</u>	<u>1960</u>	<u>1970</u>	<u>1973</u>	<u>1976</u>	<u>1960-70</u>	<u>1970-76</u>
<u>BLEACHED KRAFT PULP</u>						
Domestic Consumption	6506	13727	16700	20000	7.5	6.5
Exports	408	1567	1800	2500	14.4	8.0
Imports	1005	2220	3500	4000	8.2	10.0
U.S. Production	5909	13074	15000	18500	8.3	6.0
Capacity		13999	15452			
Operating Rate (%)		93	97			
<u>DISSOLVING PULP</u>						
Domestic Consumption	909	1124	1200	1100	2.2	-
Exports	408	869	980	1280	7.9	4.0
Imports	179	277	280	280	4.4	-
U.S. Production	1138	1716	1900	2100	4.2	3.5
Capacity		1768	1926			
Operating Rate (%)		97	99			

Sources: U.S. Department of Commerce (Past production)
 American Paper Institute (Year end capacities)
 Arthur D. Little, Inc. (Production forecasts)

We projected a slowdown in *dissolving pulp* consumption, mainly because declines are expected in the growth of rayon-acetate fiber use and because cellophane will continue to decline. These are the two largest applications. Use in cellulose esters, which is growing, will somewhat offset the declines in other domestic applications. However, projected United States production growth depends entirely on increasing exports. The projected export growth is based on continued displacement of the market share held by Scandinavian dissolving pulp producers who have higher wood costs than the United States producers. The operating rate in this sector should maintain its currently high level. There is a high degree of supply concentration in this sector; we expect the current producers to undertake the necessary expansions as they increase their market share.

C. PRICE TRENDS

Table 11 shows the trends in the wholesale price indices from 1960 to 1970 for the various reported paper industry product groups. The overall pulp and paper wholesale price index demonstrates a general pattern of price stability and relatively modest price increases over the past decade. The 11% growth, in the pulp and paper price index 1960-70 compares with a 16% increase in the general wholesale price index. This comparison understates the actual case, because prices for several important paper categories are based on list prices and do not reflect prevailing discounts. For example, a recent survey of the members of the American Paper Institute shows an "actual" index of 95 (1957-59 = 100) for all uncoated book papers in the first quarter of 1971 as compared to an index of 131 for A grade book paper, reported by the Bureau of Labor Statistics. A similar discrepancy exists for bond papers made from chemical pulp.

We attribute the relative price stability of this industry to the high degree of intra-industry competition and the general pattern of slack capacity during the 1960's. In most sectors there are at least 30 domestic suppliers. Many sectors, however, display an oligopolistic characteristic; a few suppliers share a major portion of the market. The price leadership exercised by these firms during periods of excess capacity also contributes to price stability. Prices respond to fluctuations in industry supply/demand relationships, although there is a 6- to 12-month time lag, particularly on the up side; the lag reflects the time required to react to a tightening supply and price protection clauses in some supply contracts. Figure 15 illustrates this relationship with the overall paper price index, although imperfectly, mainly due to deficiencies in the index.

The significant tightening of the supply/demand balances which we foresee for most industry product sectors in 1972 and 1973 portrays a market environment for appreciable price increases if the market is allowed to react freely. This pressure for price increases is intensified because the industry's profits are at a low point due to current weak prices (generally below 1960 levels) and cost increases

TABLE 11
WHOLESALE PRICE INDEXES

FOR
SELECTED SUBGROUPS AND CLASSES OF
WOOD PULP, PAPER, PAPERBOARD AND CONVERTED PRODUCTS

(Index 1957-59 = 100)

1960 - 1970

Item	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
PULP, PAPER & PRODUCTS.	101.8	98.8	100.0	99.2	99.0	99.9	102.6	104.0	104.9	108.0	112.3
Wood Pulp Sub-Group....	100.2	95.0	93.2	91.7	96.1	98.1	98.0	98.0	98.0	98.0	107.1
Sulphate, unbleached...	100.0	100.0	98.8	98.1	102.8	103.0	102.1	102.1	102.1	102.1	N.A.
Sulphate, Semi-bleached * N.A.	N.A.	N.A.	98.1	97.8	105.8	109.4	109.4	109.4	109.4	109.2	116.6
Sulphate, bleached.....	100.1	94.4	91.5	90.5	94.5	96.1	96.1	94.9	96.1	96.1	105.2
Sulphite, bleached.....	100.0	91.0	90.2	88.2	92.8	95.5	95.7	95.7	95.7	95.7	111.6
Groundwood.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Soda, bleached.....	100.0	89.9	87.7	82.6	86.1	90.4	90.8	90.8	90.8	90.8	N.A.
Waste Paper Sub-Group..	90.3	80.5	97.5	92.2	92.4	99.4	105.0	78.1	101.5	108.3	97.6
No. 1 news.....)			122.8	119.0	110.2	121.3	123.3	122.5	167.9	150.6	132.5
No. 1 mixed.....)			109.7	98.5	94.7	104.6	103.2	64.6	99.8	110.0	85.2
Old Corrugated boxes..)			93.8	90.8	98.3	99.5	119.2	72.3	92.9	101.5	98.0
.009 sem.chem.kr.clippings)*			98.2	90.8	101.8	108.8	116.3	76.6	96.2	114.2	111.9
.009 mixed kr.clipping) *			100.7	95.8	107.7	114.7	124.6	77.4	101.8	122.0	119.3
White news blanks.....) *			100.6	101.3	106.1	116.7	118.6	111.7	102.7	99.8	93.7
Paper Sub-Group.....	102.0	102.2	102.6	102.4	103.5	104.1	107.3	110.0	112.2	116.0	122.1
Paper, except newsprint	102.7	102.9	103.4	103.2	104.9	106.1	109.4	112.1	114.6	119.2	125.5
Printing Paper.....	102.6	101.7	101.4	101.4	101.4	101.4	101.7	101.9	101.4	102.7	N.A.
Book Paper, A grade..	105.5	106.1	107.6	107.4	109.4	110.5	115.1	117.6	119.6	122.9	128.5
Wood Bond.....	102.6	102.6	103.7	104.3	106.2	106.7	111.0	115.2	120.6	124.1	131.8
Writing Paper.....	101.7	101.8	103.0	104.2	106.3	108.8	113.2	118.3	121.2	125.8	132.4
Wrapping Paper.....	101.3	100.9	98.6	93.5	97.0	101.1	104.0	108.0	110.2	118.5	126.7
Butcher's Paper.....	102.0	101.4	101.2	100.4	102.7	105.3	107.6	109.3	112.6	117.4	121.5
Waxing Paper.....	99.8	99.8	99.9	99.9	99.9	99.9	101.0	101.5	102.2	102.2	104.1
Wrapping Tissue.....	97.6	100.4	102.7	102.7	104.1	104.2	107.3	108.8	111.3	118.8	N.A.
Newsprint class.....	100.2	100.2	100.2	100.2	100.1	98.7	101.6	104.3	105.4	108.9	112.2
Book Paper, No. 2, Offset											132.5
Paperboard Sub-Group...	99.4	92.7	93.1	94.7	96.4	96.4	97.1	97.3	91.1	94.4	96.0
Containerboard class.	99.6	91.2	92.4	94.6	97.5	97.5	97.5	97.5	87.3	91.1	93.0
Linerbd., 85-100 test	100.0	95.0	94.7	96.9	100.0	100.0	100.0	96.8	92.3	94.3	96.2
Corrugating Medium..	98.6	82.9	87.6	89.6	92.3	92.3	92.3	87.5	81.4	84.1	86.4
Folding boxboard class	99.3	94.5	93.6	94.0	93.6	93.5	95.3	95.9	96.1	98.1	98.8
Set-up boxboard class	99.1	96.9	97.1	97.7	97.4	97.2	99.2	100.1	101.9	106.5	110.3
Construction Paper & Board Sub-Group...	101.4	100.8	97.2	96.2	94.0	92.7	92.6	91.9	92.7	97.0	93.0
Converted Products Sub-Group.....	102.8	99.5	101.0	99.7	98.3	99.3	102.3	104.8	105.9	108.7	113.3
Sanitary Paper, etc....	102.9	101.9	101.1	100.7	100.5	101.2	104.3	109.7	114.4	119.6	126.4
Paper bags, shipping sacks	99.6	99.0	97.9	90.1	90.4	96.8	102.7	103.9	98.5	102.4	111.6
Boxes, shipping containers...	103.9	98.4	101.8	101.8	99.1	98.7	101.1	103.3	105.3	108.0	111.8
Packaging accessories..	103.6	101.3	99.8	98.7	98.5	99.6	102.4	111.1	103.4	104.8	105.6
Games, Toys, novelties.	100.4	100.4	102.0	102.0	102.0	102.0	102.0	112.8	115.4	117.4	124.7
Office supplies.....	101.5	102.3	102.3	103.1	102.9	103.6	106.3	107.2	107.4	107.2	108.6
Composite cans, 125-100.	--	--	--	100.0	101.3	102.4	100.7	102.6	105.8	107.7	111.9

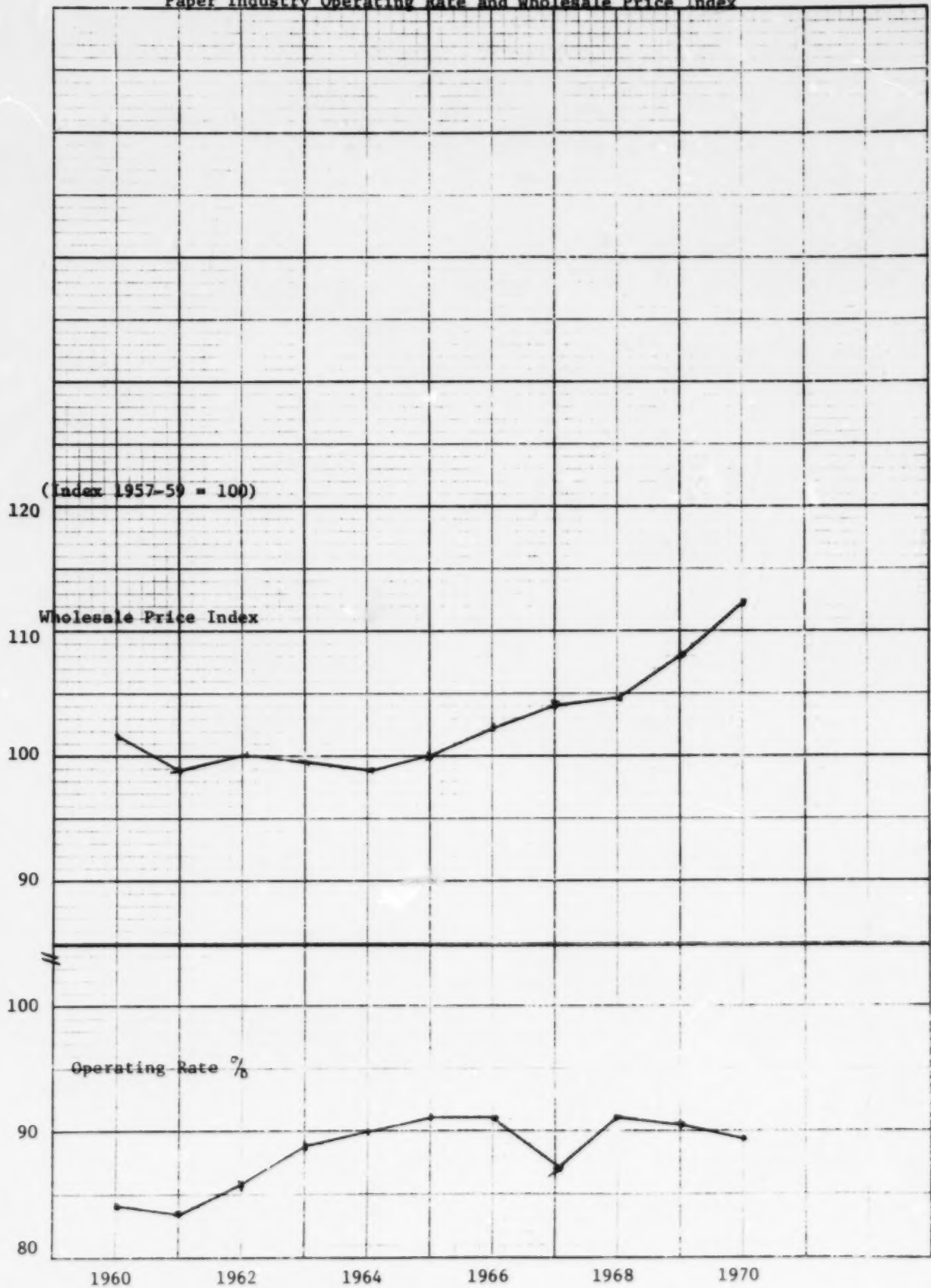
Source: Bureau of Labor Statistics, Wholesale Prices and Price Indexes, Various issues.
U.S. Department of Labor, Washington, D.C.

N.A. - Not Available

Note: Annual Figures are averages based on monthly data. * - January, 1962 = 100

Figure 15

Paper Industry Operating Rate and Wholesale Price Index



beyond those which have been offset by productivity gains. The industry's overall operating rate has remained higher during the current recession than in any previous major recession; thus the productivity gains due to increased capacity utilization are not likely to be as high during the recovery phase as they were after previous recessions. The industry is bound to seek relief from any government attempt to stabilize paper prices at their current levels.

IV. FINANCIAL STRUCTURE AND PROFITABILITY TRENDS

We found that the most relevant and current information on the financial structure and profitability trends of the pulp paper and paperboard industry comes from a survey of 38 integrated and 17 non-integrated companies which report these data annually to the American Paper Institute. The converting operations of these companies are also included in the survey. Unlike the paper industry composite used in the FTC-SEC Quarterly Financial Reports, there are no companies in the API composite that have converting operations only. The API data also depict the financial structure of the non-integrated companies. Many are closely held corporations and do not publish financial information; the composite is also broken down into company size groupings. For 1970, participating companies accounted for approximately 54% of total U.S. paper and paperboard capacity and 58% of the pulp capacity. Their net sales amounted to about 59% of net sales in the paper and allied products industries. This survey includes 18 companies whose sales were in excess of \$100 million and 21 companies whose sales were less than \$25 million; the survey represents a good cross-section of the industry, although it does not include many marginal single-mill firms.

Table 12 compares the financial performance of the participating companies by size categories in 1970. These data show that the non-integrated companies and the smaller integrated companies are less profitable than the larger integrated companies. The smaller firms also have lower borrowing power; their net worth as shown represents a larger proportion of their total capital structure. The main difference between the cost structures of the non-integrated companies and smaller integrated companies and those of the larger firms is the raw materials cost. This mainly reflects the fact that non-integrated firms pay more for pulp by buying it on the open market; also smaller firms often are unable to obtain quantity discounts on their chemical raw materials. The non-integrated firms will feel this disadvantage more over the next several years, because market prices of pulp are expected to rise.

The total cost of goods sold for the past three years amounted to about 80% of net sales; the 1970 ratio was 81.4%. Average hourly wages rose 6.2% in 1970. In 1969 an increase of 6.0% in output per man-hour helped offset the 6.2% rise in hourly earnings that year, but in 1970 the output per man-hour rose by only 1.3%. Government data on pulpwood prices indicate a continuous upward trend of about \$1/cord annual increase since 1968. Pulp prices advanced by over 9% in 1970, but wastepaper prices declined by about 10%. Sulphur prices declined sharply in 1969 and 1970, but total costs of chemicals used by the paper industry moved up sharply. A shortage of low sulphur content fuel caused an increase of about 30% in fuel prices from the 1969 level. Rail rate increases raised transportation costs for the paper companies by about 10% from the 1969 levels. Paper-making equipment rose 6.4% in 1970, which is well above the long-term trend of 2.8%/year since 1960.

TABLE 12

BALANCE SHEET AND PROFIT AND LOSS STATEMENT RATIOS - 1970

Sales: (000's)	Total All Companies	17 NON-INTEGRATED PAPER COMPANIES				38 INTEGRATED COMPANIES				
		Under \$5,000	\$ 5,000- \$10,000	\$10,000 And Over	Total	Under \$25,000	\$25,000- \$50,000	\$ 50,000- \$100,000	\$100,000 And Over	Total
BALANCE SHEET ITEMS										
(Percent Of Total Assets)										
Cash & Government Securities (including Tax Reserve)	3.3	4.7	10.2	4.9	6.3	4.8	4.8	4.4	3.1	3.3
Receivables (Net)	12.4	12.6	11.9	12.5	12.3	13.1	15.4	13.9	12.2	12.4
Total Inventories	15.0	23.3	18.3	14.9	16.2	15.6	8.9	8.2	15.7	15.0
Other Current Assets	0.6	3.1	0.8	2.5	2.1	1.4	0.5	0.3	0.6	0.6
TOTAL CURRENT ASSETS	31.3	43.7	41.2	34.8	36.9	34.9	29.6	26.8	31.6	31.2
Timberlands (Net)	7.4	0.0	0.0	0.0	0.0	1.1	8.2	10.6	7.2	7.4
Plant, Equipment, and Other Property	98.3	100.9	106.7	118.2	114.4	105.9	99.8	103.4	99.4	98.1
Reserve	46.2	48.1	54.4	56.3	55.4	47.3	46.5	44.9	46.1	46.1
TOTAL FIXED ASSETS	59.5	52.8	52.3	61.9	58.9	59.6	61.5	69.1	58.4	59.5
Other Assets	9.2	3.5	6.5	3.3	4.1	5.4	8.9	4.1	9.8	9.3
TOTAL ASSETS	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total Current Liabilities	14.1	12.7	12.2	14.1	13.6	12.8	11.8	13.7	14.2	14.1
Other Liabilities (Long-Term Debt Deferred Credits,Etc.)	30.8	6.6	21.0	25.4	23.4	18.2	31.7	30.6	31.0	30.9
Net Worth	55.1	80.7	66.8	60.5	63.0	69.0	56.5	55.5	54.8	55.0
TOTAL LIABILITIES AND NET WORTH	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
PROFIT & LOSS STATEMENT										
(Percent Of Net Sales)										
Sales:										
(Net Of Returns, Allowances, All Discounts, And Sales Excise Taxes)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Depreciation	4.4	4.3	4.4	4.3	4.4	4.2	6.6	7.0	4.1	4.4
Depletion	0.4	0.0	0.0	0.0	0.0	0.1	1.5	0.4	0.4	0.4
Labor**	23.8	29.2	21.1	20.5	21.1	22.7	21.2	23.2	24.0	23.8
Other Costs***	52.8	46.5	56.7	65.6	62.2	57.7	49.6	49.2	2.9	52.7
TOTAL COST OF GOODS SOLD	81.4	80.0	82.2	90.4	87.7	84.7	78.9	79.8	81.4	81.3
GROSS OPERATING PROFIT	18.6	20.0	17.7	9.6	12.3	15.3	21.1	20.2	18.6	18.7
Less:										
Selling, General And Administrative Expenses	11.5	17.1	8.5	10.4	10.2	10.4	15.1	6.9	11.8	11.5
NET OPERATING PROFIT	7.1	2.9	9.2	- 0.8	2.1	4.9	6.0	13.3	6.8	7.2
Less: Other Income And Expenses, Net	0.5	0.6	1.0	0.4	0.6	- 0.1	- 0.5	1.0	0.5	0.5
NET INCOME BEFORE INCOME TAXES	6.6	2.3	8.2	- 1.2	1.5	5.0	6.5	12.3	6.3	6.7
INCOME TAXES	2.5	1.8	3.5	- 0.6	0.6	2.2	3.0	5.8	2.3	2.5
NET INCOME AFTER INCOME TAXES	4.1	0.5	4.7	- 0.6	0.9	2.8	3.5	6.5	4.0	4.2
CASH DIVIDENDS PAID OR DECLARED	2.8	0.7	4.0	1.2	1.9	1.3	1.0	2.2	3.0	2.9

SOURCE: A.P.I. Annual Capital Income Survey.

NOTES:

- ** Labor. Includes All Wages And Salaries, Except those included under "General, Selling and Administrative Expenses."
 *** Includes such costs as Raw Materials, Maintenance and Repairs, Interest, etc.
 Components may not add to total due to rounding.

With only a modest increase in 1970 sales and a considerable increase in costs, the after-tax profit margin for the paper industry dropped to its lowest level right after World War II. In 1970 and during the first half of 1971 the industry tried to bring its costs under control. Although labor costs are expected to rise, productivity is expected to increase substantially due to cost reductions and increased capacity utilization in 1972. Many inefficient mills were closed during 1970 and early 1971; this will help raise the average level of efficiency for the industry. However, at present the financial performance reported by 39 publicly held paper companies for the first nine months of 1971 indicates an average profit decline of 28% from the same period in 1970. Thus the industry is still caught in a cost/price squeeze mainly due to weak prices and current overcapacity.

As shown in Table 13, the non-integrated companies have attained consistently lower profit margins since 1960. This profitability differential was accentuated during the cost/price squeeze in 1970. The current profitability differential is likely to continue through 1976, because market pulp prices are expected to rise steeply; also most non-integrated companies cannot attract enough capital to increase their scale of operations, to backward-integrate to pulp production, or to achieve product diversification.

The declining proportion of equity capital or net worth reflects the increasing importance of debt financing in the capital structure of most paper companies. Although this trend should have resulted in increasing return on net worth, the general decline in return on total assets and the increasing cost of debt capital during the 1960's caused it to decline in recent years. The declining trend in return on total assets understates the real earning power decline, because the paper company asset values do not reflect the rapidly increasing value of their timberlands.

A. PROFITABILITY VARIATIONS BY PRODUCT SECTOR

Since most paper companies produce a wide variety of both paper and paperboard grades, some of which are produced in the same mill, it is impossible to measure meaningfully product line profitability from published information. Since we intend in our second report to show the cost/price structure for key products which will be most affected by increased pollution abatement costs, it is sufficient at this point to assess qualitatively the relative profitability of the various product sectors.

We have found that the profitability of a given product sector at a point in time usually relates directly to the degree of capacity utilization. One can obtain a reasonable conception of how each sector ranks in profitability outlook by reviewing the operating rate forecasts presented in Chapter III. On this basis the

TABLE 13

PERCENTAGES OF TOTAL ASSETS, SALES, NET WORTH

INTEGRATED COMPANIES: 1957 - 1970														
	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
PERCENTAGE OF TOTAL ASSETS														
Sales	91	89	96	97	100	100	100	101	104	102	94	94	101	97
Net Worth	68	68	69	71	71	70	70	69	66	62	60	58	57	55
Profit Before Taxes	12.7	11.1	12.5	11.6	10.7	10.7	10.4	10.5	10.8	11.3	8.0	8.3	9.3	6.5
Federal Taxes	6.0	5.4	6.0	5.7*	5.2*	5.2*	4.8*	4.4*	4.4*	4.6*	2.9*	3.3*	3.8	2.4
Profit After Taxes	6.7	5.8	6.5	5.9	5.5	5.5	5.6	6.1	6.4	6.7	5.1	5.0	5.5	4.1
Dividends	3.7	3.4	3.4	2.9	3.4	3.4	3.3	3.3	3.2	3.0	2.9	2.8	2.8	2.8
PERCENTAGE OF SALES														
Total Assets	110	112	104	103	100	100	100	99	97	98	106	106	99	103
Net Worth	75	77	72	73	71	70	70	68	64	61	64	61	56	57
Profit Before Taxes	14.0	12.5	13.1	11.9	10.7	10.7	10.4	10.3	10.5	11.1	8.5	8.8	9.2	6.7
Federal Taxes	6.6	6.0	6.3	5.9*	5.2*	5.1*	4.8*	4.3*	4.2*	4.5*	3.1*	3.5*	3.8	2.5
Profit After Taxes	7.4	6.5	6.8	6.1	5.5	5.5	5.6	6.0	6.2	6.5	5.4	5.3	5.4	4.2
Dividends	4.0	3.8	3.6	3.0	3.4	3.4	3.3	3.3	3.1	3.0	3.1	2.9	2.8	2.9
PERCENTAGE OF NET WORTH														
Total Assets	146	147	144	141	140	143	144	145	152	161	168	174	176	182
Sales	133	130	138	138	141	143	143	147	157	164	157	169	177	176
Profit Before Taxes	18.6	16.3	18.1	16.4	15.0	15.2	14.9	15.1	16.5	18.1	13.3	14.7	16.4	11.8
Federal Taxes	8.8	7.8	8.7	8.1*	7.3*	7.4*	6.9*	6.3*	6.7*	7.4*	4.8*	5.8*	6.7	4.5
Profit After Taxes	9.8	8.4	9.4	8.3	7.7	7.9	8.0	8.8	9.8	10.7	8.5	8.9	9.7	7.3
Dividends	5.3	4.9	4.9	4.1	4.8	4.8	4.7	4.8	4.9	4.8	4.9	5.1	5.0	5.0
NON-INTEGRATED COMPANIES: 1957 - 1970														
	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
PERCENTAGE OF TOTAL ASSETS														
Sales	140	136	144	132	122	115	118	113	123	132	128	128	119	114
Net Worth	72	74	75	76	72	73	74	70	72	66	69	70	64	63
Profit Before Taxes	12.7	10.2	13.6	12.9	11.7	10.4	9.9	8.5	10.5	12.2	9.0	9.4	7.7	1.8
Federal Taxes	6.5	5.1	6.8	6.6*	6.3*	5.5*	4.9*	3.4*	4.5	5.4*	4.0*	4.2*	3.5	0.7
Profit After Taxes	6.2	5.1	6.8	6.3	5.4	4.9	5.0	5.0	5.9	6.8	4.9	5.2	4.2	1.1
Dividends	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.2	2.5	2.0	2.4	2.4	2.6	2.2
PERCENTAGE OF SALES														
Total Assets	71	74	69	76	82	87	87	88	82	76	78	78	84	87
Net Worth	51	54	52	57	59	63	63	62	59	50	54	54	54	55
Profit Before Taxes	9.0	7.5	9.5	9.8	9.6	9.0	8.4	7.5	8.6	9.3	7.0	7.4	6.5	1.5
Federal Taxes	4.6	3.8	4.8	5.0*	5.2*	4.7*	4.2*	3.0*	3.7	4.1*	3.2*	3.3*	2.9	0.6
Profit After Taxes	4.4	3.7	4.7	4.8	4.4	4.3	4.2	4.4	4.9	5.2	3.8	4.1	3.6	0.9
Dividends	1.5	1.6	1.5	1.7	1.9	2.1	2.2	1.9	2.1	1.5	1.9	1.9	2.2	1.9
PERCENTAGE OF NET WORTH														
Total Assets	139	135	133	132	138	136	135	142	139	152	146	144	156	159
Sales	195	184	192	174	168	157	160	161	170	199	187	184	186	182
Profit Before Taxes	17.7	13.8	18.2	17.1	16.2	14.2	13.4	12.1	14.5	18.5	13.1	13.5	12.1	2.8
Federal Taxes	9.0	6.9	9.1	8.8*	8.7*	7.5*	6.7*	4.9*	6.3	8.2*	5.9*	6.0*	5.5	1.2
Profit After Taxes	8.7	6.9	9.1	8.3	7.5	6.7	6.7	7.2	8.2	10.4	7.2	7.5	6.6	1.6
Dividends	2.9	2.9	2.9	3.0	3.1	3.3	3.4	3.1	3.5	3.7	3.6	3.4	4.1	3.5

SOURCE: American Paper Institute, "Annual Capital Income Survey."

least profitable product sectors, in approximate *ascending* order of 1970 profitability, are:

Least Profitable

Combination paperboard
Insulation board
Construction paper
Special industrial paper
Semi-chemical corrugating medium
Unbleached kraft packaging paper
Coated paper (particularly the publication grades)
Uncoated book, writing and related paper
Tissue paper

Most Profitable

The sectors destined to maintain a condition of excess capacity through 1973 are more relevant to our analysis. These sectors, in approximate *ascending* order of future profitability, are:

Poorest Outlook

Insulation board
Semi-chemical corrugating medium
Special industrial paper

Best Outlook

Our analysis shows that each of the above product sectors will be operating below 90% of capacity at the end of 1973; the rest of the industry will be significantly above this level. Firms in these sectors therefore, should be least able to accommodate the capital and operating costs associated with increased pollution abatement requirements. It will be more difficult for them to achieve price increases to cover additional pollution abatement costs; and to attract capital for the required capital expenditures, because of their relatively low profitability.

B. CAPITAL FLOW RELATIONSHIPS

To illustrate the relationship between capital flows and profitability in the paper industry, we have plotted trends in these relationships since 1960 (Figures 16-19).

Figure 16

Total Paper Industry Profit and Capital Expenditure Trends

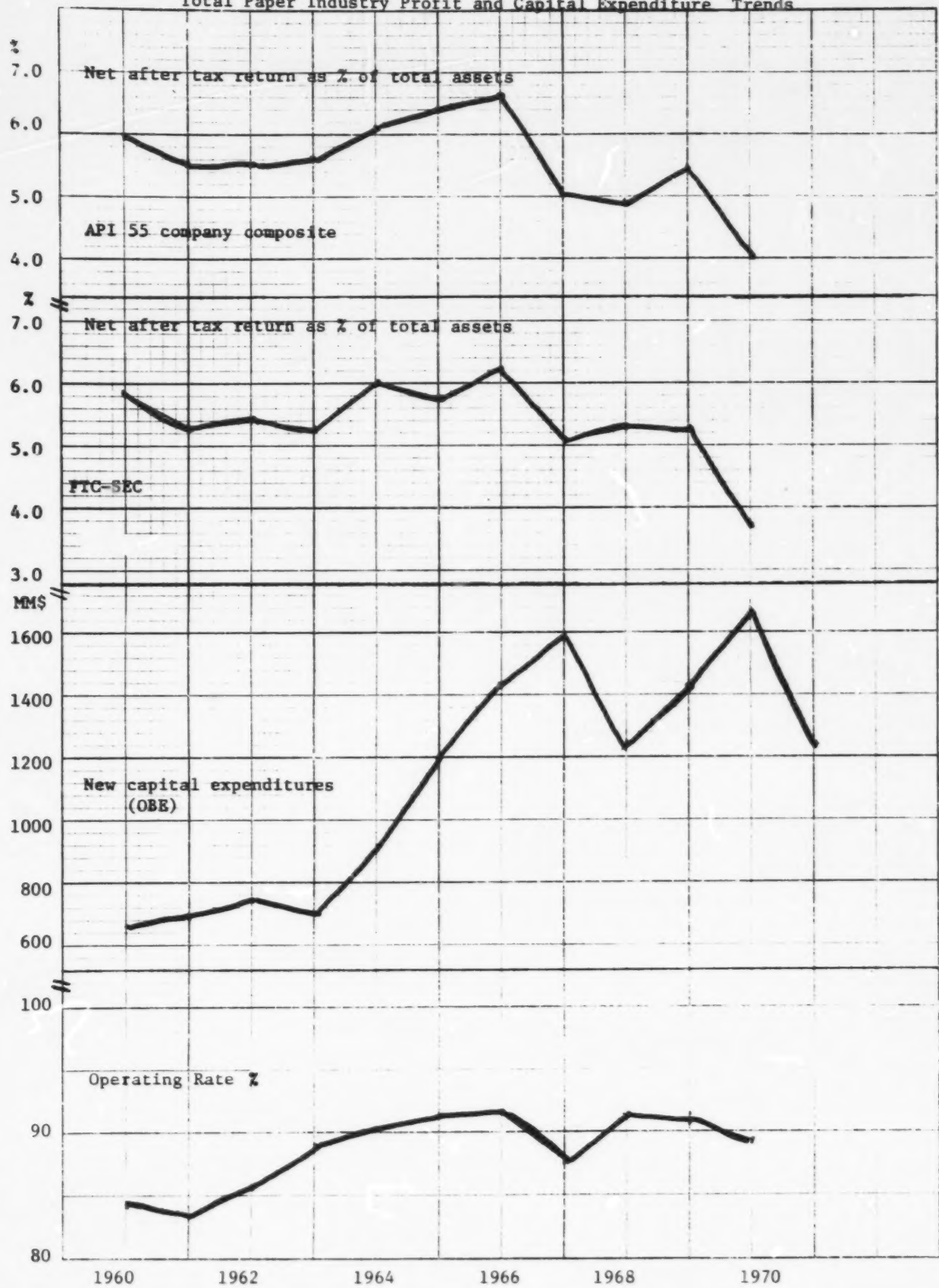


Figure 17

Pulp, Paper and Paperboard Sector Profit and Capital Expenditure Trends

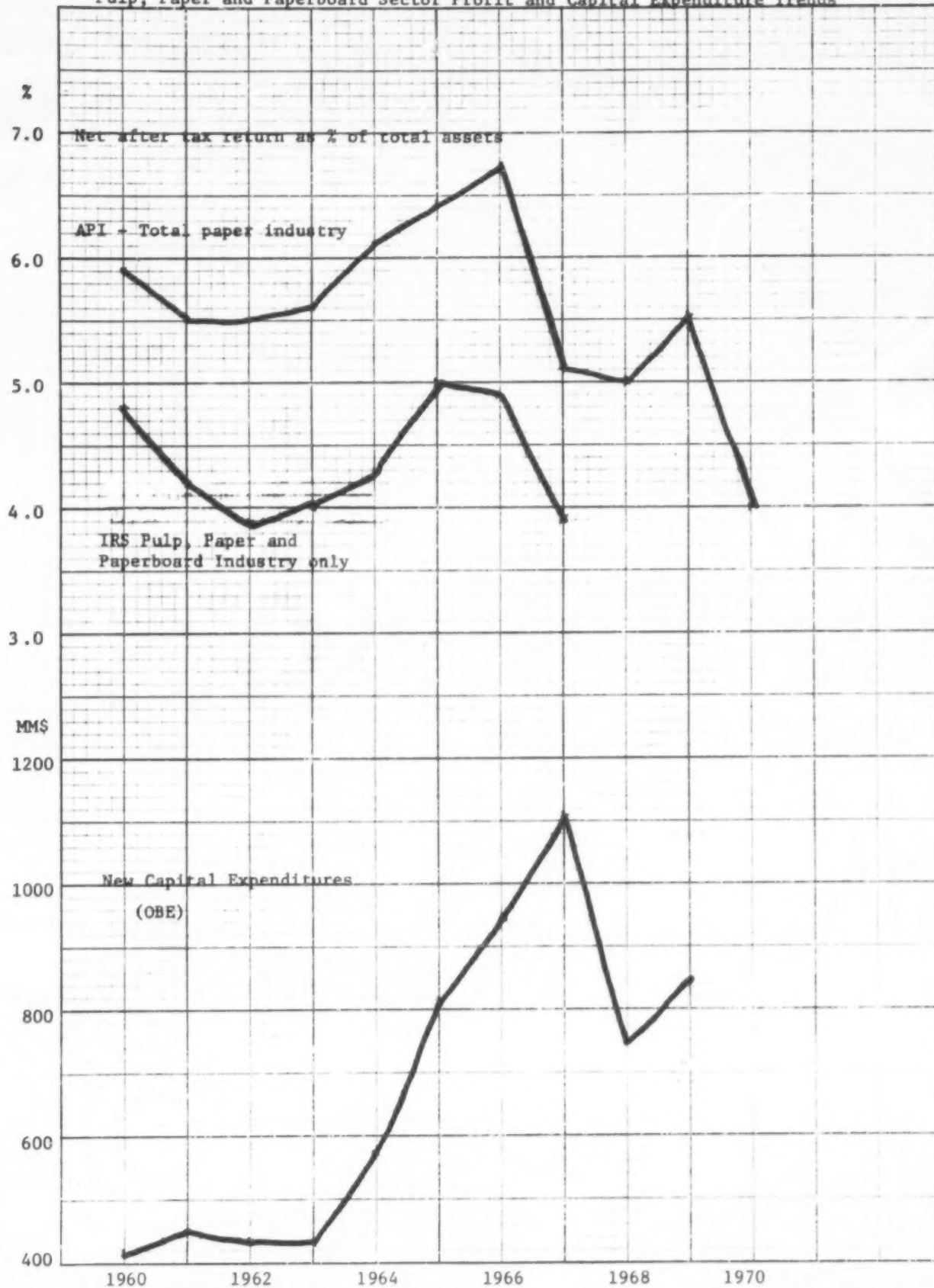


Figure 18
Pulp, Paper and Paperboard Sector Profitability and Capital Expenditure Relationship

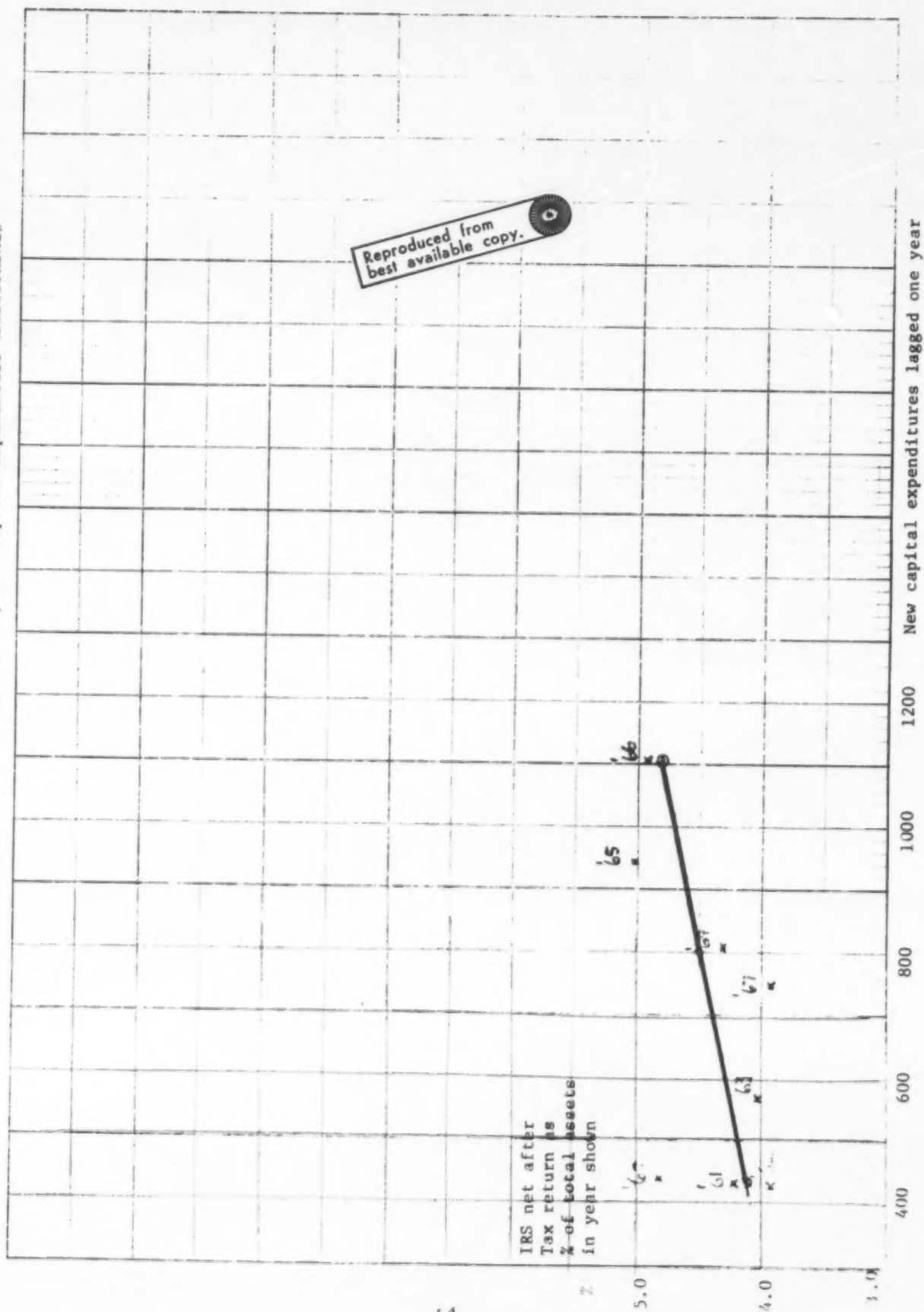


Figure 19

Total Paper Industry Profitability and Capital Expenditure Relationship

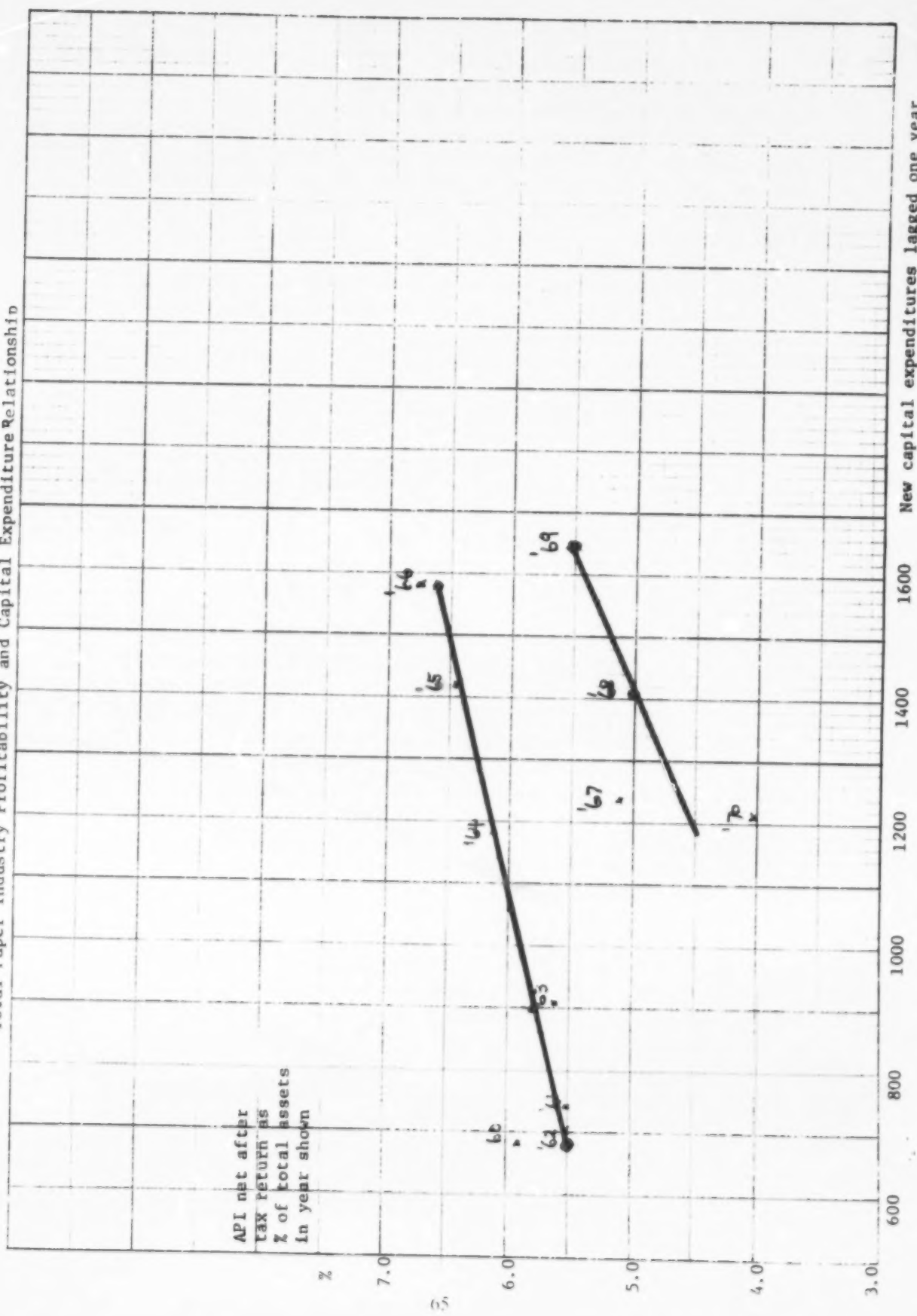


Figure 16 compares the trend in total industry operating rates and profitability with the trend in new capital expenditures. Changes in profitability fluctuate directly with changes in operating rates; changes in new capital expenditures succeed profit and operating rate changes by about one year. Also illustrated is close correlation between the profitability trends of the API company composite and the FTC-SEC quarterly financial samplings. The profitability levels reported by the FTC-SEC have been consistently lower than those reported by the API composite.

Figure 17 shows the relationship between profitability and capital expenditures more specifically for the pulp paper and paperboard sectors, which are most directly affected by increasing pollution abatement costs. This correlation employs profitability data derived from the Internal Revenue Service based on total tax returns of all pulp, paper, and paperboard companies. These data differ from the FTC-SEC profitability samplings in that companies solely engaged in paper converting operations are excluded. The profitability levels reported by the IRS have been consistently lower than the profitability of the API company composite; the latter does not include many of the smaller and least profitable firms in the industry. The capital expenditure trend in Figure 17 is also specific to the pulp paper and paperboard sectors. Again, fluctuations in capital expenditures usually occur about one year after changes in profitability. This relationship between profitability and capital expenditures is shown in Figure 18.

An even more interesting relationship between profitability and capital expenditures lagged one year is shown in Figure 19; here this relationship is compared for the total paper industry. By virtue of utilizing more current profitability data than that published by the IRS, this analysis shows a step change in the relationship between capital expenditures and profitability, starting in 1967. Apparently, the industry has been more willing to commit greater amounts of capital at lower levels of profitability in recent years. A number of explanations can be offered for this changed relationship: the effect of inflation on capital equipment costs; the trend toward larger scale mills to obtain increased productivity and offset labor cost increases; and more importantly, significantly higher capital expenditures for pollution abatement equipment.

This step change in the relationship between profitability and capital expenditures also indicates that the paper industry management and owners, at least temporarily, have been willing to accept lower returns on their capital expenditures. We believe that aside from a long-standing over-emphasis on production volume, the paper industry has been a low-risk business. Therefore, the companies within it have become accustomed to accept commensurately low profit expectations in justifying new investments. However, this trend certainly cannot continue indefinitely. With increasing interest costs the paper industry may not be able to

afford nor attract sufficient debt capital at the profitability levels of recent years. Equity financing does not offer a more attractive alternative to debt financing at today's depressed stock prices.

The concern about attracting sufficient capital is accentuated because the risk level appears to be increasing significantly in the paper industry. One easily measured element of risk over the past decade is the industry's increasing reliance on long-term debt. Many paper companies have now borrowed to their maximum limits. This factor and rising interest rates now make the industry heavily dependent on equity financing for future expansion. However, return to the equity shareholders can be expected to fluctuate more widely now because of the leveraging effect of heavy interest and principal repayment charges. Also, the intense national concern over environmental protection has raised new uncertainties over the last few years. Besides implementing increased water and air pollution control programs, the paper industry now faces possible restrictions on its timber harvesting practices and mounting pressure to recycle more of its products; thus major changes in raw material supply are created. Substitute materials — e.g., plastics — have partially eroded traditional paper markets. Increasing timberland taxes reflecting competitive uses for this land and possible changes in capital gains laws add to the uncertainties. Some if not all of these uncertainties are likely to materialize into greater dispersion and fluctuations in profitability among firms in this industry. Such variability is a basic sign of increasing risk. To restore its profitability to former levels and to compensate for additional risk, the industry is likely to attempt vigorously to increase prices when supply/demand balances are favorable.